THE

ENGINEERING MAGAZINE

VOL. VI. FEBRUARY, 1894. No. 5.

HOW THE ANCIENTS MOVED HEAVY MASSES.

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FIRST PAPER.

IT is well known to students of architecture and engineering that the ancient practitioners of these arts employed in buildings and monuments stones of much larger dimensions than it is customary to use in modern times. Travelers in the older countries gaze with wonder upon masses still remaining in the quarry, or in place in buildings,—upon wall-stones and lintels, columns and entablatures,—that far surpass in magnitude any quarried or erected in our own day. The question forces itself upon the attention of student and traveler alike: How did the builders of ancient edifices convey and elevate into position such enormous masses of stone as the ruins of their work still reveal to us?

The information on which we must rely for an answer to this question exists in no concentrated form, but is broadly scattered through the pages of history, and among the ruins of structures, and the remains of mural sculpture and paintings, whose discovery has rewarded the laborious researches of a multitude of enthusiastic archæologists during the past century. It is the purpose of the writer to collect, as fully as the limits of a magazine article will permit, the scattered evidences of the mechanical ways and means employed by the ancient architects and engineers, with a view to giving as satisfactory an answer to this constantly-recurring inquiry as is possible in the present state of our knowledge.

NOTE.—The following works have been consulted in the preparation of these papers:
The Architecture of Leon Baptista Alberti (English edition), London, 1755.
Histoire de Polybe, par MM. Thuillier et Folard, 6 volumes, Amsterdam, 1729.

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The earliest means employed for lifting and removing large bodies doubtless was the application of the muscular strength of as many men as could be employed effectively,—without machinery or apparatus of any kind,—directly to the body to be moved.

This practice gradually yielded to the employment of mechanical means, though it is sometimes resorted to even at the present day. Within the memory and observation of the writer, the heavy timbers and planks used in shipbuilding were taken up an inclined plane—or "brow," as such inclined planes were then called—and placed in positions in the manner shown in the engraving on page 613, in which a party of workmen are seen ascending the "brow," carrying a timber on their shoulders. There were several objections to this primitive method of carrying heavy masses by mere muscular strength. It was by no means certain that, even if the men were of equal height, they would each carry his proper proportion of the load, for there have always been men who tried to shirk their responsibilities and thrust their burdens upon others; and even if every man was disposed to do his full duty, in moving over irregular ground the weight carried would be sure to be unequally distributed. Furthermore, there were many masses moved by the ancients whose shape made it impossible for men to handle them by mere muscular strength, although the weights might not be excessive.

M. Vitruvii Pollionis de Architectura, Venetiis, 1567.
Agricola, de re Metallica, Basileæ, 1556.
Professional Papers of the Royal Engineers, Vol. X, London, 1849.
L'Art de Batir les Vaisseaux, Amsterdam, 1719.
The History of the Arts and Sciences, by Rollin, London, 1768.
Origin of Laws, Arts, and Sciences, by Gouguet, 3 volumes, Edinburgh, 1761.
A Thousand Miles up the Nile, by Amelia B. Edwards, London, 1890.
History of Ancient Egypt, by George Rawlinson, M. A., 2 volumes, Philadelphia, 1882.
The Discovery of Jerusalem, by Captains Wilson and Warren, R. E., London, 1871.
Rawlinson's Ancient Monarchies.
Wilkinson's Manners and Customs of the Ancient Egyptians, 3 volumes.
Rawlinson's Herodotus.
Discoveries in the Ruins of Nineveh and Babylon, by Austin H. Layard, London, 1853.
Egyptian Obelisks, by Lieutenant-Commander Henry H. Gorringe.
Pyramids and Temples of Gizeh, by W. M. Flinders Petrie.
Life and Work at the Great Pyramid, 3 volumes, by C. Piazzi Smith.
Edinburgh Philosophical Transactions, Vol. IX, 1821.
Edinburgh Philosophical Transactions, Vol. IV.
Ewbanks's Hydraulics, New York, 1850.
Egypt, Descriptive, Historical, and Picturesque, by G. Ebers.
Tanis and Noucratis, by W. M. Flinders Petrie.
Anthropological Journal, 1883.
Operations at the Pyramids, by Colonel Howard Vyse, 1840.
The Land of the Pharaohs, by Rev. Samuel Manning, LL.D., London.
Le Diverse et Artificiose Machine del Capitano Augustino Ramelli, 1588.

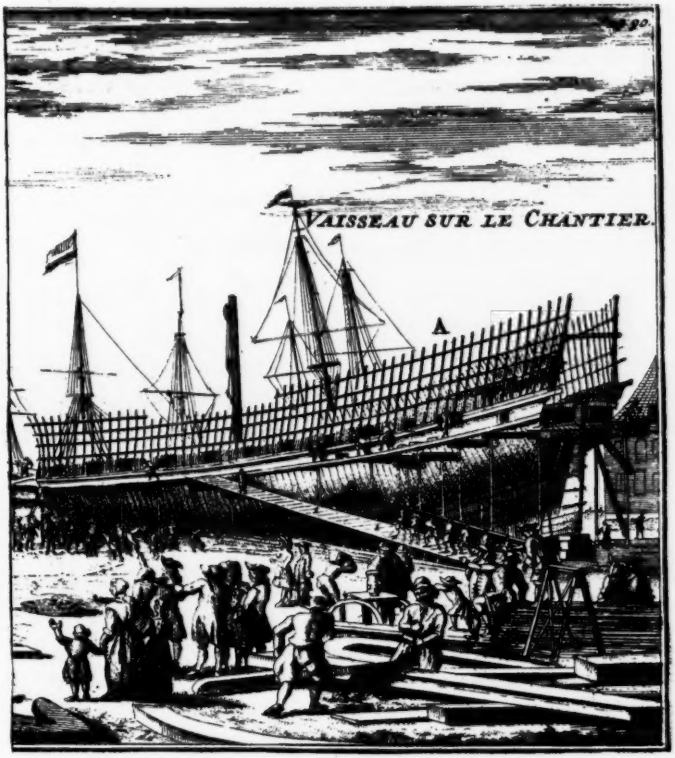


FIG. 1.—CARRYING TIMBER ON MEN'S SHOULDERS.
[From "L'Art de Batir les Vaisseaux," Amsterdam, 1719.]

For the preservation of the means of overcoming these objections to the early manual method of mere lifting and lugging we are indebted to the Chinese. In 1846 certain buildings for the Ordnance Department at Hong Kong were erected by Chinese workmen under the superintendence of Major Edward Aldrich, R. E., who stated that the men were "very ignorant of the value of machinery and averse to its use"; and that "all land transport for the ordnance building for every description of article has been performed solely by manual labor"; and that "462 granite columns," "each weighing 38½ cwt.," were carried "from the quarry to the building," a distance of "about half a mile," by "the united

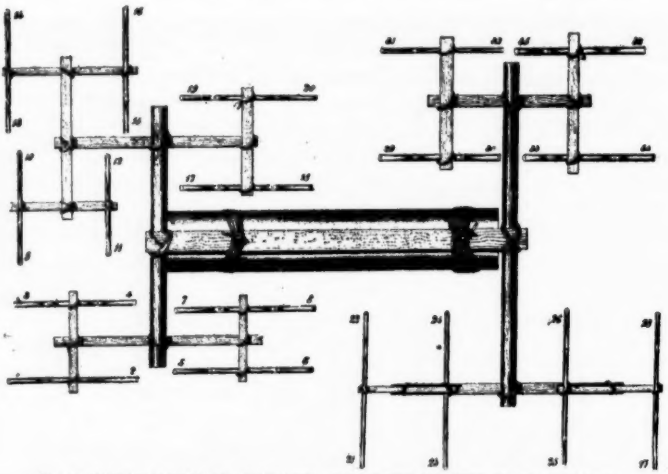


FIG. 2—CHINESE DEVICE FOR EQUALIZING LOAD IN THE CARRYING OF HEAVY MASSES.

power of 36 men" applied as shown in Figures 2, 3, and 4. Very little explanation is necessary to the understanding of these engravings. Figure 2 is a plan of the combination of timber and bamboo to which the column was secured by "lashings," and the peculiar "swingletree" articulation of the several parts of this very ingenious and simple mechanism was such that each man located at the numbered ends of the bamboo rods was obliged to carry just as much as, and no more than, any other man in the party. No man could possibly avoid doing his allotted share of the work, whatever his stature or the irregularities of the ground to be traversed. In Figure 3 the men are seen carrying one of the columns; "in moving they all kept step, occasionally changing step, at the same time removing the weight from one shoulder to the other."

Major Aldrich thus comments upon this very simple and effective operation: "At the present day the attention of the world is so engrossed by scientific improvements that the power of manual labor in its simple and single state is lost sight of, and to an extent that we now look upon the Egyptian and Grecian monuments of art with amazement. Our busy thoughts are puzzled to describe the mode adopted for their erection, and we almost leave the consideration with the impression that their erection without the application of mechanical powers was impossible. The means, how-

FIG. 3.—THE CHINESE DEVICE APPLIED IN CARRYING A COLUMN.

ever, used in the transport of heavy weights by the Chinese at this station, on the ordnance buildings, recalls our attention to the power of manual labor in its simple state, to the united strength of men, and to the gigantic power derived by such unity,—pointing clearly to the feasibility, by such simple means, of undertaking even a building in rivalry of the Temple of the Sun at Heliopolis."

The sled seems to have been a favorite vehicle in ancient Egypt and Assyria for the conveyance of heavy loads, and there is no evidence offered by wall-paintings or sculptures that wagons were known in the early days of these countries, though two-wheeled carts and chariots were common, the last being a most important item in the equipment of an army. According to Diodorus Siculus, the chariots of Sesostris (2600 B. C.) numbered 27,000; and Joshua (1450 B. C.) tells us that the Canaanites had "chariots of iron." Later Sisera had "900 chariots of iron." The use of iron for chariots is evidence that it could have been used for the cutting of stone. Solomon (1000 B. C.) obtained a

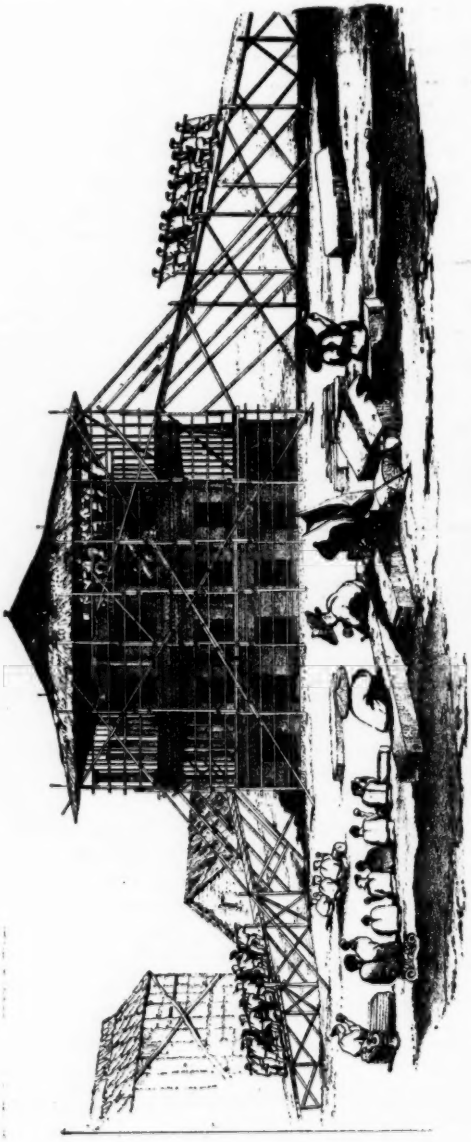


FIG. 4.—THE CHINESE DEVICE APPLIED IN CARRYING LOADS UP AN INCLINED PLANE.

chariot from Egypt at a cost of "600 shekels of silver" (about $300) which was probably used as a model for the fourteen hundred which he placed in "the chariot cities" of Judea. But while the ancient Egyptians and Assyrians were well acquainted with the use of wheels they do not appear to have employed them in transporting building stones or large masses of any kind. The sled seems to have been the vehicle chosen for such purposes by each of these nations, being drawn sometimes by oxen, but not infrequently by large numbers of men.

FIG. 5.— ANCIENT USE OF THE SLED, SHOWN IN A PAINTING AT EL MAUSARA.

A painting at El Mausara (Figure 5) shows a sled, of which we find a survival in the "stone-boat" or "drag" of our day, laden with a large mass of stone, and drawn by six oxen. In Figure 6 we have a representation of a funeral-barge resting upon a sled drawn by oxen. Figure 7 illustrates the transportation of a colossus from a tomb at El Bersheh (2600 B. C.), upon a sled drawn by men. Great care seems to have been taken to secure the colossus to the sled by means of ropes made "taut" by twisting them by sticks. Where the ropes cross finished parts of the sitting figure and the chair soft material is interposed to prevent the ropes from abrading the stone.

The ancient Assyrians seem to have improved upon the Egyptian method of employing the sled. Two sculptures discovered by Layard at Nineveh (Figures 8 and 9) show the operation of transporting by means of a sled a human-headed bull. In Figure 8 the bull is represented as lying on his side, but in Figure 9 he is standing upright, his legs being relieved from the danger arising from sudden shocks during transit by blocking beneath the body, which removed a large part of its weight from the legs. In each engraving it will be noted that rollers were used beneath the runners of the sled. These rendered the use of lubrication unnecessary, so that a man with a grease-pot was not needed in front of the sled, as in the Egyptian practice. A long lever is used behind the sleds to assist in putting them in motion or to raise their rear ends out of some depression in the road. In Figure 8 the king is seen in a canopied chariot supervising the operation, and in the left foreground are a couple of capstans; ropes, rollers, and levers are provided in abundance; the "gang-boss" occupies his commanding position; a party of men seem to be removing stones and other rubbish from the route of the sled; and everything indicates careful preparation for the work in hand. Sleds are shown by Egyptian tomb-paintings to have been used to convey live wild animals in cages.

The Egyptians excelled all the nations of antiquity in quarrying large masses of stone and transporting them over long distances. In the plain of Quorereh there are two colossi of Ameno-

FIG. 6.—AN EGYPTIAN FUNERAL BARGE RESTING UPON A SLED.

phis III (about 1400 B. C.) of a single block each, (one of these being the vocal Memnon) forty-seven feet in height, containing about 11,500 cubic feet (about 1000 tons) of a stone not known within several days' journey of the place. Herodotus states that 2000 men were occupied three years in bringing from Elephantine to Sais by order of Amasis (569 to 525 B. C.) a single block of stone hollowed out for use as a small temple or sanctuary. This mass was $31\frac{1}{2}$x22x12 feet externally, and $28\frac{1}{4}$x18x$7\frac{1}{2}$ internally, and weighed about 400 tons. The monolythic temple which Herodotus says was transported from Elephantine to Birto in the Nile delta was a sixty-feet cube externally; if we suppose its walls to have been six feet in thickness it must have weighed upwards of 5000 tons.

The transportation of large masses of stone by water-craft was a common practice in ancient times, in both Assyria and Egypt. A bas-relief of Koyunjik* (2000 B. C.) il-

*George Rawlinson's "Five Great Monarchies," Vol. I, p. 421.

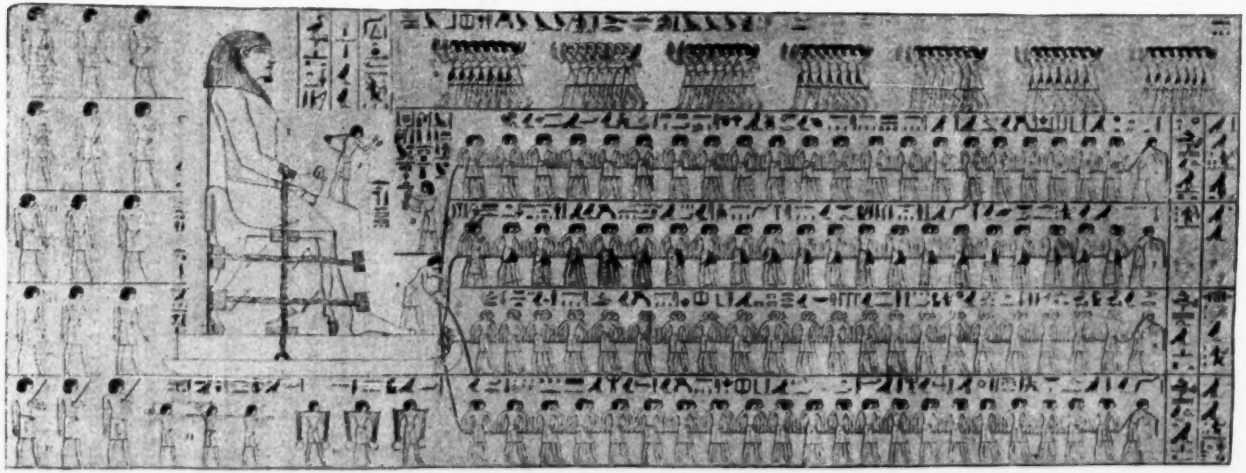


FIG. 7—TRANSPORTATION OF A COLOSSUS (FROM A TOMB AT EL BERSHEH).

[The sled is drawn by 172 men, divided into four companies of 43 each. At the top of the picture is shown a relief party, and at the bottom three men carrying a liquid, by means of yokes. In front of the sled a man is pouring a lubricant upon the ground. Standing on the knee of the Colossus a "gang-boss" appears to be "marking time" by clapping his hands.]

lustrates the conveyance of stones by means of a raft or pontoon supported by the inflated skins of animals. It is absolutely certain that all the limestone used in the pyramids of Gizeh (3200 to 960 B. C.) was moved in part by water, as the quarries from which it was obtained are located east of the Nile. Pliny tells us that obelisks were transported down rivers upon two flat-bottomed boats which were lashed together side by side, and admitted into a basin cut at right angles to the bank of the river beneath the obelisk. These boats were loaded with a quantity of ballast exceeding in weight that of the block to be transported, and when they were secured in proper position below the stone the ballast was thrown out, and the boats rising, as they were lightened, bore

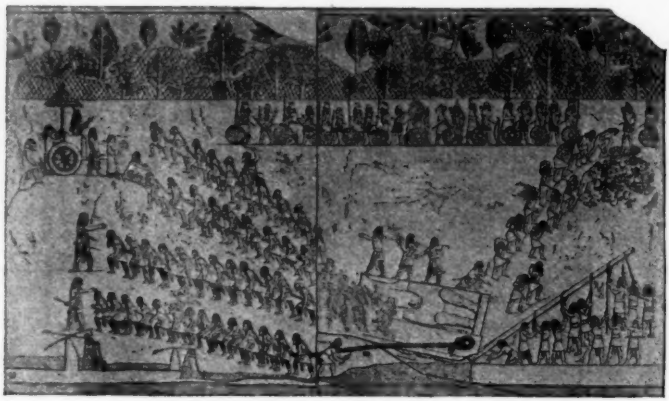


FIG. 8—REMOVAL OF A COLOSSAL BULL AT NINEVEH BY MEANS OF A SLED.
[From a sculpture discovered by Austen H. Layard.]

away the obelisk instead of their previous burden. Pliny credits one Phœnise with the invention of this method, but fails to say at what period he lived.

The architects and engineers of Asia Minor deserve credit for the invention of some highly-original methods of transporting rough columns and large rectangular blocks. Chersiphron, the architect of the great temple of Diana at Ephesus (600 to 560 B. C.), —which was accounted among the seven wonders of the world,— included in its design 127 columns of marble sixty feet high and about seven feet in diameter. Vitruvius states that Chersiphron, observing that the roads were not firm enough to bear the weight

of such vast columns upon carriages whose wheels would sink into the ground, contrived a frame as shown on the right of Figure 10. This consisted of four timbers enclosing the rough-hewn column. At the center of each end of the column he fixed a large iron pin, barbed at the end within the stone, and well secured with lead. The projecting ends of these pins passed through iron bearings in the end cross-pieces of the frame. Poles of oak were secured to two of the corners of the frame by iron hooks and strong iron rings. Oxen were attached to these poles and as they moved forward the column turned and was drawn with no great difficulty to Ephesus, a distance of eight miles.

Following out the idea of Chersiphron, his son Metagenes, who

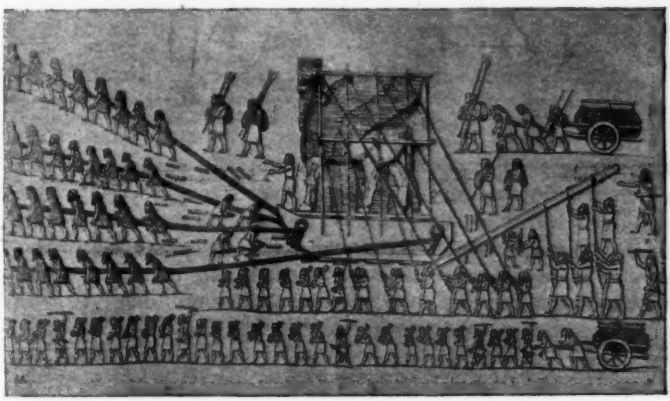


FIG. 9—ASSYRIANS TRANSPORTING A HUMAN-HEADED BULL.
[Partially restored from a bas-relief at Kouyunjik.]

succeeded him as architect of the temple, contrived the method illustrated on the left of Figure 10 for conveying architraves, some of which were thirty feet in length. He made strong and broad wheels about twelve feet in diameter, in the center of which he fixed the architrave, having large iron pins in the middle of each end; these pins turned in bearings in the end cross-pieces of the enclosing frame, in the same way as the column, and oxen were attached to poles to draw the stone as before described.

In the time of Vitruvius (about 30 B. C.) one Paconius undertook to bring from the mines the base (twelve feet high, eight feet broad, and six feet thick) for a colossal statue of Apollo. His

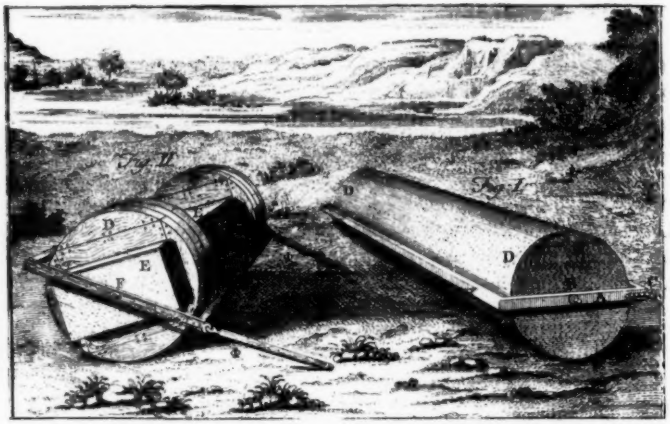


FIG. 10—CHERSIPHRON'S DEVICE FOR CONVEYING COLUMNS TO THE TEMPLE OF DIANA AT EPHESUS.
[Shown in the section of the picture to the right. On the left is shown a modification of this method, invented by Metagenes.]

machine, though somewhat similar to that of Metagenes, was of a different construction. It consisted of two strong wheels (Figure 11) fifteen feet in diameter, into which the ends of the stone were fixed. Through the rim of these wheels round spokes were driven. Around these spokes a cable was wound, and to this the oxen were attached for setting the machine in motion. But Vitruvius

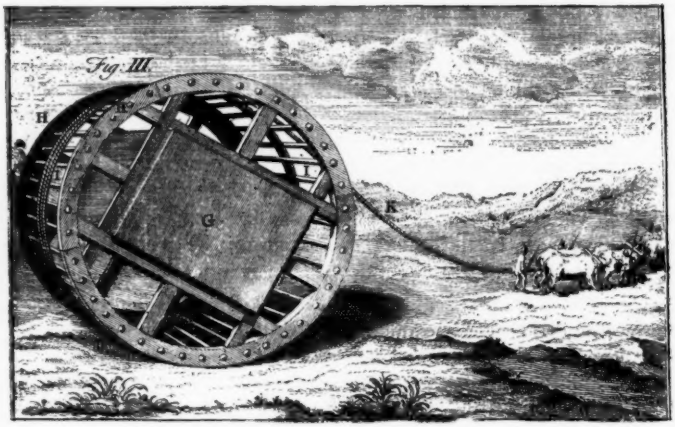


FIG. 11—DEVICE OF PAEONIUS FOR TRANSPORTING THE BASE OF A COLOSSAL STATUE OF APOLLO.

says that as the cable never drew from any fixed or central point, the machine continually turned either to the right or to the left, and could not be made to answer its intended purpose. M. Perrault expresses surprise at this and suggests that, by adding another cable to equalize the draft, it might have been made a better machine than that of Metagenes.

One of the methods employed by the ancient engineers for moving large masses is well illustrated by the means taken to move the vast towers of timber used in the attack of fortified places.

Such towers were called Heleopoli, or city-takers, and were said to have been invented by Demetrius Poliorcetes (Demetrius the Besieger) and first used by him at the siege of Rhodes (305 B. C.) Figure 12* illustrates the general constructive features of such towers, which were always constructed beyond the range of the offensive powers of the besieged, and then filled with armed men, and drawn towards the intended point of attack in the way shown in the engraving,—the men operating the capstans being protected from injury by the tower itself. As soon as the tower reached a point sufficiently near the invested place, the two-leaved drawbridge (seen on the right of the tower) was suddenly lowered upon its wall, and a storming party rushed from the tower over this bridge and took forcible possession of the immediate vicinity of the point of attack ; reinforcements were rapidly pressed forward by means of the tower and its bridge, and in the meantime (such times were always "mean" to the vanquished) the defenders of the place were constantly annoyed by arrows, stones, and other missiles discharged from the top of the tower, which was always made high enough to command the point attacked.

Some of these towers were over a hundred feet in height. Anna Comnena (born A. D. 1083), in describing in her "Alexiad" a tower used at the siege of the city of Duras, says: "It was square and of such prodigious height that it exceeded the towers of the city. It was intended to descend from it upon the walls by its bridges, and to fall upon those that defended them with an irresistible impetuosity. This tower was terrible to see even afar off, as it advanced like a giant whose rapid strides nothing could resist. It

* From the Chevalier Folard's commentary on Polybius' "History of the Art of War." [Amsterdam, 1729.] Polybius the historian, soldier, traveler, lawgiver, and diplomatist, was born about the year 204 B. C. and died when eighty-two years of age. His history is one of the most valuable of ancient writings that we have inherited. The work originally consisted of forty books, of which only five have been preserved entire ; many are entirely lost and of others we have but fragments.

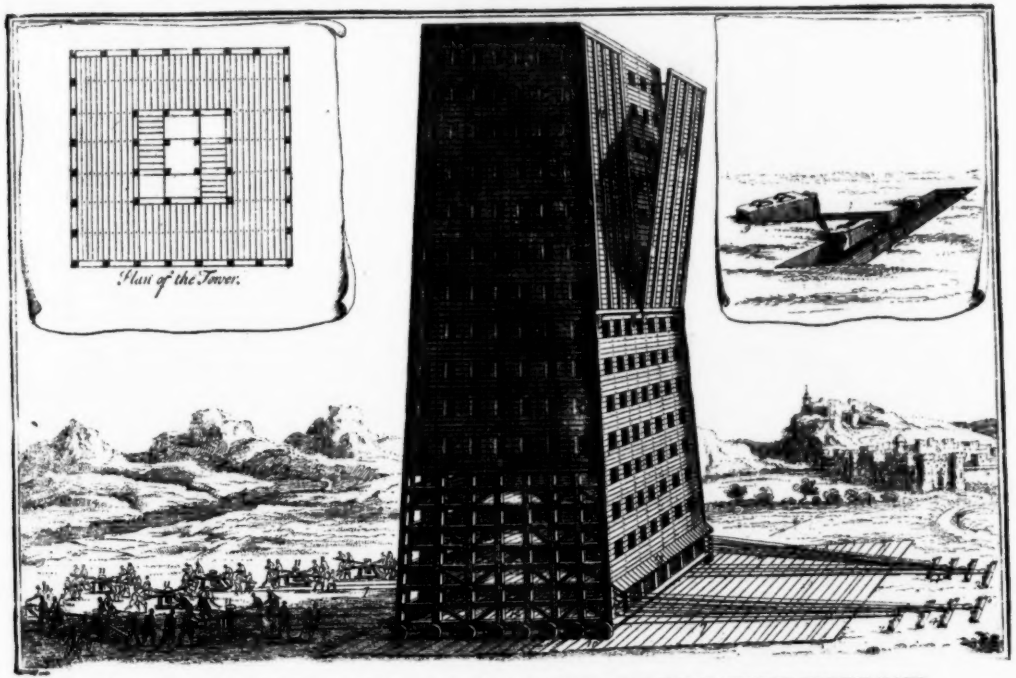


FIG. 12—PLAN OF CONSTRUCTION AND METHOD OF REMOVAL OF ANCIENT TOWER USED IN ATTACKING FORTIFIED PLACES.

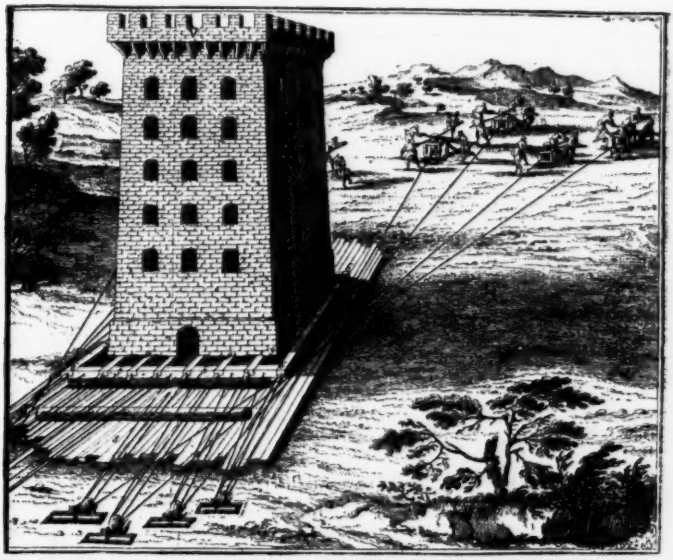


FIG. 13—REMOVAL OF A MASONRY TOWER BY A BOLOGNA ARCHITECT IN THE FIFTEENTH CENTURY.

was pierced by a great number of openings through which men shot incessantly. The highest floor was full of men with swords in their hands which never rest from slaughter."

The removal of the Seringapatam obelisk (about 1815) from the quarry to its intended site, a distance of two miles, by native Hindoo workmen unaided "by any European," is thus described by Colonel Wilkes: "The carriage on which the shaft of the obelisk was conveyed from the quarry was supported by eight wheels or rollers, four without, and as many within, the cheeks of the machine. . . . It required about 600 men to drag the obelisk, and the operation was extremely tedious."

In Figure 13 is shown the method of moving a tower of masonry adopted by an architect of Bologna in the fifteenth century.* It will be noted that the operation was similar to that of moving the Heleopolis of Demetrius, but in this case large cylindrical rollers were used instead of wheels; this feature, however, was not novel, having been used frequently for moving military towers.

* The removal of masonry buildings while families were residing in them during the operation has been accomplished successfully a number of times in America. The writer of this paper removed a factory chimney eight feet square at its base and 100 feet high, weighing by computation 170 tons. The operation was entirely successful, and the cost much less than a new chimney.

LABOR'S DELUSION REGARDING CAPITAL.

By Alfred H. Peters.

THE belief prevails among many members of the laboring class, more especially among the organized bodies therein, that the chief obstacle to their advancement, both material and immaterial, is capital, or wealth employed in the production of more wealth. It is easy to prove, on the contrary, that capital is the least of the forces against which labor has to contend ; that it is not so much an active force as a passive instrument in that contention, and that if labor had no other force to contend against it might, whenever it chose, put capital under its foot. Let the intelligent laborer but reflect upon the situation and he can hardly fail to perceive that it is not capital, but forces infinitely more powerful, that takes advantage of labor ; forces that take advantage of capital no less than of labor,—the forces of intellect and of will.

Suppose that all capital, all money, all investments of money, were to be turned into ashes or sunk within the bowels of the earth —what would be the result? The purely capitalist class, those whose incomes are derived from rent, interest, or any other return that comes not through individual effort, would indeed for a brief time cease to be an element in industrial economy ; but does any one suppose that the action of that economy would change? Not at all. Society would forthwith reorganize upon the same general line as before. The keenest heads would be in most demand, and therefore receive the highest reward, while the dullest heads would be in least demand, and therefore receive the lowest reward ; between which all the other heads would be ranged with positions and rewards according to the degrees of skill and intelligence. First would be preferred the men of organizing and directing ability, hard upon whom would follow the men of persuasive ability, who would themselves be followed by the men of foresight and invention ; and so on down through the different orders of ability to the man whose only ability was his muscular force,—always understanding, however, that human nature continued the same, and that the most part of human energy was expended to the end of individual aggrandizement. Against this inequality in social organization no laws or institutions avail, because it is nature's fixed decree that mind shall be the master and muscle the servant.

In this manner would intellect assert its supremacy. At the same time the other master faculty, will, the foundation of whose power is diligence and self-restraint,—less imperious but more persistent, and in the long run more certain than intellect,—would also assert itself. Everywhere would be found those who, how small soever might be the value of their energy, would assiduously exercise it and reserve the greater part of their return therefor. Intellect often is spendthrift and ready to mortgage itself to the future, as well as being generous withal, but will, when bent upon fortune, lives only in the future and is, respecting the present, as merciless to others as to itself. Little by little, with indefatigable resolution and self-denial, would this hard but conquering force in an increasing ratio make itself a social power. It matters not what might be the object of accumulation—money or bonds or houses or lands or cattle or slaves—so long as it was the object of man's desire. Out of this genius for accumulation capital is for the most part created; and, as in the case of intellect, no laws or institutions avail against it, because he who lives for the future shall survive and he who lives only for the present shall perish.

Capital has been oftentimes, if not wholly, yet in large measure thus dissipated or destroyed. The thirty years' war devoured the accumulated resources of Germany; the French revolution and the wars of the first empire consumed the surplus wealth of France, and the American revolution ended with the practical disappearance of capital from the colonies for nearly a generation. None of these convulsions, however, changed the fundamental principles of social economy. Men went to work directly, as order was restored, with mind at the head and muscle at the foot as before; every one expending his energy as best he might to the end of satisfying whatever was uppermost in his desire. The only difference between a society with capital and a society without capital in respect to rank is that in the former condition intellect becomes the head in name as well as in fact; whereas in the latter condition intellect often is content to remain the head in fact while permitting capital to become the head in name.

Now it is here maintained that this capitalless condition is at all times the real condition of the most part of productive human energy. Ninety-nine hundredths of the intellect and will, as well as of the muscle, that come into the world come into it with no other capital. The only office that capital performs is to increase human activity and productiveness. Wherever there is capital, there will

be found the greatest number of those desiring to use capital; and wherever capital finds most employment there always does the most labor congregate. Not only from its own land but from every other land is labor attracted toward good management and thrift, of which capital is no more the enemy than it is the enemy of labor. Rather is capital the friend or would-be friend of all three,—inasmuch as it is the means whereby they obtain a fuller satisfaction of their desire. When labor can find no employment it is either because capital has been destroyed, or because intellect falls out or overreaches itself, or because thrift becomes frightened and withdraws its store from use.

Labor is a tax paid either by ignorance to intelligence, or by self-indulgence to self-restraint, a tax from which capital cannot escape any more than can labor. Consider the constant exactions and depredations to which, from both these forces, capital is obliged to submit,—the thousand devices whereby astuteness, or intellect, frightens or befools or forces capital into gratifying its desire. Consider also the habitual toil and frugality whereby self-restraint, or will, constantly increases the volume of capital; the value of which is thus diminished and the return thereon reduced. Labor cannot be long taxed to its destruction, nor to a degree whereby it ceases to be productive, but capital often is forced to risk annihilation in order to become productive. Labor does indeed often lose much through the devices of intellect, but capital through the same devices often loses all; in which case its former possessor, when it is his sole possession, becomes of all men the most helpless. Moreover, the men who are the most successful users of capital, and therefore the greatest concentrators of capital,—men in whom superior intellect and superior will are united to the end of personal emolument,—come in the majority of instances from labor's own ranks. The greatest managers and accumulators of capital are for the most part men who, or whose fathers, were born of parents belonging to the laboring class.

No one denies this fact: that the creators of capital, from the savings-bank depositor up to the director of vast industries, are commonly sprung from the laboring class of society. The man of inherited capital is seldom a moving-spirit in the industrial world. He may be the nominal head of some industrial or commercial enterprise, as formerly a prince of the blood was the nominal head of some military enterprise, but the real head—he upon whom the success of the enterprise most depends—probably began life with

no other capital than a clear head and a stout heart. When one thus equipped is discovered capital fairly throws itself at his feet. Instead of endeavoring to retard the intelligent and resolute son of labor, capital is constantly endeavoring to advance him; provided always that his intelligence and resolution be exercised upon traditional and established lines. Capital is loath to further innovation or to exalt individual independence. It is always upon the side of authority, and expects subservience on the part of the other forces of society, as it is always subservient itself.

Who are the capitalists? Those whose fathers or grandfathers were enabled through genius, or talent, or courage, or accident, or subservience to leave fortune to their offspring,—the class of leisure and of fashion? Those who have built up great manufacturing, or distributing, or carrying enterprises,—captains of industry so-called? Those who deal in money and loans and credits,—the directors of great banking and trust institutions? As commanders of segregated capital these may be better known and individually more important, but of capital in the aggregate they own but a fractional part. The bulk of capital is owned by those whose labor, either for themselves or for others, is labor of the hands more than of the head. Consider, in addition to the accumulations of hired laborers, the accumulations of laboring proprietors,—small farmers, artisans, and traders,—whose labor, being mostly of the same kind as that which they employ, makes them, economically speaking, as much laborers as proprietors. Consider the aggregate of savings-bank deposits, of life-insurance policies, and of all manner of small investments, to say nothing of the farmsteads and the homesteads, the tools and the implements which are the property of the laboring and semi-laboring classes. Every laborer or laboring proprietor who has reserved a portion of the product of his labor is relatively just as much a capitalist as are they who employ his savings, and oftentimes more so.

More than the dependence of labor upon capital is the dependence of capital upon labor. Were labor to cease capital would soon perish. The store of that which sustains civilization would without replenishment be exhausted in a few years, and the store of that which sustains life is never sufficient for more than a year in advance. The enemies of capital should have lived during those ages when man's main business was war—the destruction instead of the production of capital; when whatever industry that existed was left to women or to slaves; when a short supply meant a raid

upon one's neighbors, and famine was at all times never very far off. Do those who inveigh against the industrial system ever consider what has been, economically speaking, the principal result of that system? It has been an enormous increase in the volume of civilized human life. Everywhere the most industrious nations are the most populous nations. The more industry, the more life. If the creation of capital, and consequent industrial development, be an evil, the way to diminish it is to diminish the quantity of life.

It is not to be denied that industrial civilization bears hard upon labor,—in respect to the concentration of energy and individual responsibility harder than when the laborer was a chattel or a feudal appendage; nevertheless labor would not exchange the free service of railway and factory proprietors for the enforced service of barons and bishops. Herein also the grievance of labor is no greater than the grievance of every other form of human energy that is in the market. He who would in our time find employment at another's hands must apply himself strenuously toward his employer's ends, whether his work be of the hand, the head, or the heart; and whosoever would enjoy freedom must accept responsibility therewith. Let not this or any of the other grievances whereof labor complains be charged upon capital, however. They are to be charged, if chargeable at all, upon the mind that is behind capital,—human intellect devoted to progressive, or speculative, or competitive ends. He from whom labor suffers most, be it the method-displacing inventor, the ambitious ruler, the enterprising projector, or the close-calculating industrial manager, is always and everywhere the incarnation of some master mind. Of such ones capital may and may not be the instrument. James Watt without capital rendered useless the skill which labor had acquired through the practice of many generations. Bonaparte without capital forced into arms half the labor of Europe, and the late Jay Gould, during a large portion of his career, with comparatively little capital controlled the labor of an entire railway system. The injury done to capital in every one of these instances exceeded the injury done to labor a hundred-fold.

Nor must the grievances of labor be charged wholly upon the master directors of industry—the ones that through any means whatsoever disturb the conditions of labor or dictate the terms of its employment. The greater part of the professional class, as well as of the trading class, are as much responsible for the advantage taken of labor as are the master managers of industrial enterprise.

Every one who obtains a livelihood through the ignorance, or credulity, or vanity, or curiosity of labor; every one who caters for his own profit to its appetites and passions; the demagogue who obtains office by flattering it, the agitator who lives by inciting it to idleness and violence—is not labor a constant sufferer from all of these? Indeed he who possesses just enough intellect and just enough will to raise himself one degree above the average circumstance of labor is, when he sets about beguiling it, the one from whom labor suffers most.

If labor would escape subjection to these master faculties, and at the same time preserve its freedom, it must acquire them itself. In every advantage taken of labor it is itself, through lack of these faculties, in more or less measure an accomplice. Every abuse of legislative or of proprietary or of managing authority, as well as every professional device whereby labor is taxed for the gratification of individual pride, or ambition, or ease, or greed, exists only by reason of labor's deficiency in intellect or in will. And labor is acquiring these faculties and has been acquiring them for the last hundred years. Herein labor has advanced just far enough to be conscious of its strength; and, feeling that some force is operating against it, charges the offense upon capital, the mere instrument of the offending powers. It is to be noted that the strongest of the labor organizations are those whose members are skilled laborers, and therefore the more intelligent and self-restrained. The question for labor to consider is whether it can gain most by individual action or by collective action. Individual action permits the intelligence and self-restraint among labor to rise and take its place alongside other intelligence and self-restraint. Collective action, upon the principle of arbitrary equalization, chains him in whom the master faculties are developed to the mass of those in whom they are undeveloped. Labor may not emancipate itself by forcing a self-denying ordinance upon intelligence and thrift, nor destroy the opportunity of any other class of society without at the same time destroying its own.

In proportion as individual energy is free, in like proportion is the reward of individual ability. Nay, in like proportion also, when more than one generation is considered, is fortune most evenly distributed. The denunciations against the individualistic economy come from men who are incomparably more selfish than the individualist,—men whose desires and expectations are centered in the present if not in themselves. Consider the course of fortune

for the last hundred years in the United States. Who are the men of greatest fortune among us to-day? The descendants of the Dutch patroons or of the English patentees or of the opulent colonial merchants of Boston, Philadelphia, and New York,—the landlords and millionaires of a century ago? On the contrary they are the descendants of those who a hundred years ago were impecunious professional men, or farmers, or craftsmen, or European peasants; in many instances men who began life as such themselves. Meantime the descendants of those whose names a century ago stood for power and affluence may be found depending upon daily toil for their subsistence. The same process has been going on in Great Britain, notwithstanding the legal barriers that still remain, and wheresoever else individualism has obtained against paternalism; and the result will be the same during the next century as during the present one. The free play between those who have and those who have not, from one generation to another, is the surest equalizer of human fortune.

In these forces of intellect and will is involved the whole matter of man's inequality, which, like every other human question, is mainly a question of degree. The man who in civilized life is at the bottom of society would, if he were thrown among a tribe of savages, be at the top of society; as shipwrecked sailors become dignitaries among the South Sea islanders, and escaped convicts the patriarchs of the Australian bush. Intellect is master of men because it wields weapons which the mass of men are unable to wield; and will is master of men because for the sake of ultimate gain it denies itself that of which the mass of men refuse to be denied. This inequality is felt by the purely capitalist class as much as by the purely laboring class, many of which envy nothing so much as superior intellect and superior will, and many more of which sorrowfully confess that material abundance and refinement have served them but as an enemy in all strenuous endeavor. Man is by nature a discontented animal. Satisfy one of his desires and forthwith he feels the sting of another. He who supposes discontent to be peculiar to one class of society is but a poor student of human life. Many specifics have been prescribed for man's discontent, none of which avail because, instead of a malady to be cured, discontent is that part of the divinity within him. The only medicine that assuages this divine discontent is persistent endeavor, lack of opportunity whereof toward some manner of improvement is the only grievance of which man may justly complain.

INDUSTRIAL CONDITIONS IN MEXICO.

By John Birkinbine,

Past-President American Institute of Mining Engineers.

MEXICO has been described as "a country of contradictions"; it certainly is a land where extremes meet most unexpectedly. The traveler will find long stretches of nearly level plain terminating abruptly in high mountain ranges, whose steep sides obstruct any passage more pretentious than a burro-trail. From the unwatered desert with its sparse vegetation of sage-bush and cacti, a few steps transport one to luxuriant growths of plants and trees in great variety, stimulated by irrigation. On Sundays and feast-days in the Alameda of the capital, or on the plazas of other Mexican cities, the sandalled feet and scant clothing of peons and Indians are intermixed with elegant and costly costumes worn by bejewelled señores and señoritas, with their "proud Castilian bearing." From the windows of railway-cars one may see men, women, and children carrying heavy burdens and maintaining a jog trot in competition with traffic by rail and steam. In the mineral districts modern steam or electric machinery elevates water and ore, while in adjacent mines notched sticks serve as ladders, and *bateas* of hide containing water and ore are lifted by oxen dragging around the bars of *malacates*, or even by manual labor. The new drainage-canal for the city of Mexico is being excavated in part by improved steam-dredges, and in part by peons clad only in sandals and breech-clouts, who carry on their backs *morales* filled with earth. Many other such surprises could be suggested to illustrate the close association in Mexico of the old and the new which exerts such a decided influence upon industrial development in that republic.

In the past decade Mexico has made great advances, and there is reason to believe that the future will be marked by greater progress. But new enterprises for the near future must be based largely upon a condition of affairs closely allied to that now existing. The country cannot in fairness, however, be judged by its status prior to the development of its railways. These have caused modifications and changes appreciated only by those who knew Mexico before the locomotive wakened the echoes of its cañons. While

its traditions and customs which have been recognized for centuries still prevail, Mexico is making advancement which must be recognized in discussing any projected investment; yet the peculiar environments must not be overlooked.

Some of the conditions which will confront Mexican enterprises demand radically different treatment from those which prevail in the United States, and a failure to appreciate these is emphasized by plants of expensive machinery bought for use in Mexico which either lie idle or have been relegated to the scrap-pile. The more prominent conditions to be considered in establishing industries in Mexico are (1) an abundance of cheap labor; (2) concentration of the bulk of the population in limited areas; (3) great distances and differences in elevation to be overcome in bringing various sections of the country into trade relations; (4) a general scarcity of domestic fuel; (5) comparatively restricted capital; and (6) intermittent or uncertain water-supply.

Of the 11,600,000 souls constituting the population of Mexico, fully two-thirds may be classed as peons (laborers) and their dependents, the great mass of whom, by reason of their habits and their taste for games of hazard, are in debt to their employers and are practically serfs. Labor consequently commands a low rate of compensation. The *Two Republics*, an English newspaper published in the city of Mexico, said in a recent editorial: "It is officially announced that the average daily wage in this country is 27 cents. This is probably at least 10 cents more than it was twenty years ago. In ten years we believe it will average 50 cents."* The writer has found through personal inquiry that in various portions of the republic laborers receive for working "from sun to sun" from 18 to 75 centavos, according to the tasks assigned and the section of country in which the labor is performed. The maxima and minima of wages paid are therefore from 9 to 13 and 38 to 56 cents per day, in United States money. This labor, though cheap, adapts itself readily to changing conditions, and consequently is a drawback to the use of labor-saving appliances.

The total area of Mexico is 767,206 square miles, with an average population of 15 per square mile. The eleven "central States" have an area of but 18 per cent. of the whole, while their population represents nearly 50 per cent. of all the inhabitants of the

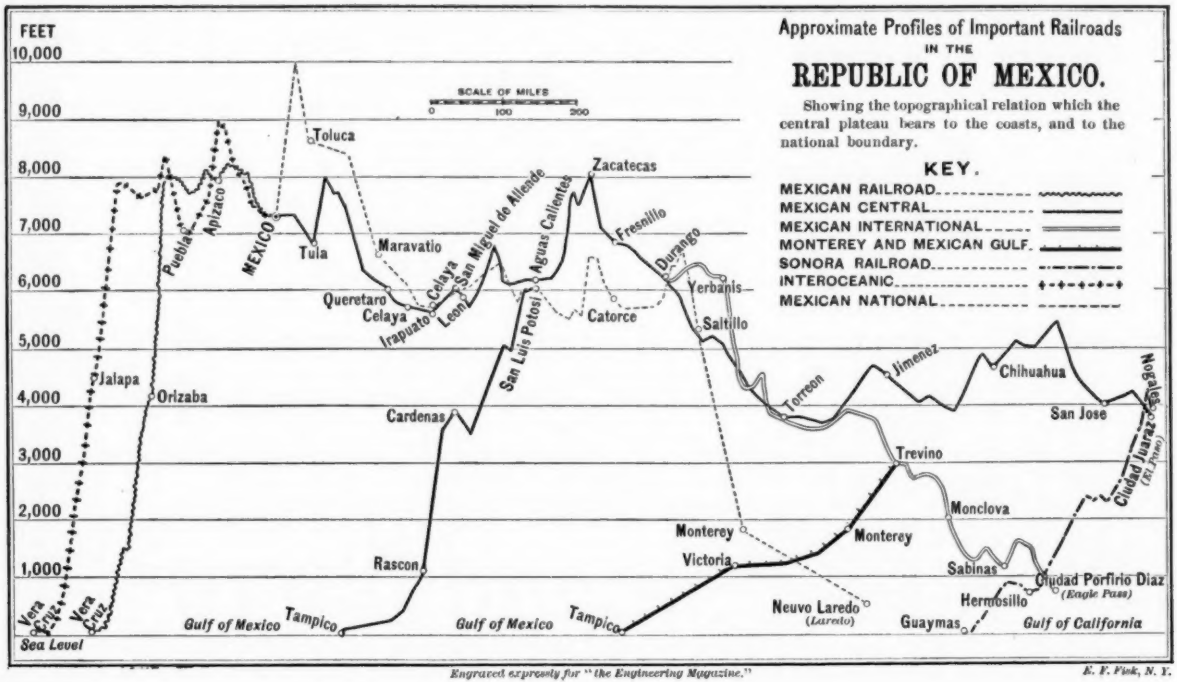
* The "cent" referred to is the *centavo*, of which 100 are equivalent to one *peso*, or Mexican dollar. It has a commercial value varying, with the rate of exchange, from one-half to three-quarters of a United States cent.

republic, the number per square mile being 39. A circle having a radius of 100 miles from the city of Mexico would include a population of nearly 2,500,000. In this area are numerous towns of large size and commercial importance. If a radius of 200 miles were used the circle would include the gulf ports of Vera Cruz and Tuxpan and the Pacific port of Acapulco, and embrace a population of fully 5,000,000. Nearly half of the inhabitants of the republic, therefore, reside within 200 miles of its capital. The remaining half of the population is scattered throughout eighteen States and Territories, averaging less than 10 per square mile. As the remote States include some important cities and populous districts, it is evident that much of the area is sparsely settled, and that, outside of the merchants in the cities and the owners and managers of haciendas and mines, the great majority of the people in these States may be classed as peons.

The greatest width of the republic (750 miles omitting lower California) is at the latitude of the mouth of the Rio Grande, and but about half that distance at the latitude of the capital, the width continuing to decrease to the isthmus of Tehuantepec. In crossing from the United States into Mexico a rapidly-increasing elevation is found as the Rio Grande is ascended, this increase being from ocean level at Matamoras to 3700 feet at Paso del Norte, and between the latter point and the Gulf of California greater altitudes are encountered. Humboldt is credited with the assertion that the so-called great central plateau of Mexico could be traversed anywhere between the mountain chains by a stage-coach, and to-day the Mexican Central railroad tracks follow this plain, having a general ascent from Paso del Norte to Zacetacas and the city of Mexico, each approximating 8000 feet. As this so-called great plateau is bounded and intersected by mountains reaching much greater elevations, the coasts of either the Gulf of Mexico, the Pacific ocean, or the Gulf of California can be reached from it only by long detours or abrupt ascents and descents.

Mr. E. Prieto Basave states* that in 1891 about 6,000,000 passengers and 3,000,000 tons of freight were carried, and estimates the earnings of the railroads of Mexico during 1892 at 12,000,000 pesos. He gives the total cost of all Mexican railroads, aggregating a length of 6389 miles, as $200,000,000, of which $76,000,000 was advanced by the government in subventions, the balance being principally American and British capital. Most of the roads have

*Transactions American Society of Civil Engineers, Vol. XXIX.



Engraved expressly for "the Engineering Magazine."

E. F. Fisk, N. Y.

followed the great plateau, and in but few instances have the lines constructed had to overcome the gradients and developments necessary to reach the high lands from the comparatively narrow strips of *terra caliente* which skirt the gulfs and ocean.

In a recent address before the Engineers' Club of Philadelphia the writer made the following statement concerning the changes noted in eleven years, together with data upon the profiles of various Mexican railways, and the accompanying diagram* has been introduced to emphasize the statement as far as the main lines of the more prominent roads are concerned:

In a late trip I rode between 500 and 600 miles, in comfortable sleeping-cars over territory which little more than a decade ago was accessible by slow, exhausting wagon-travel only, requiring camps on the plain, or stops at ranches far from other habitations. The story I then told to wondering, if not skeptical, natives, of travel at the rate of ten to fifteen *leguas* (twenty-five to forty miles) per hour in the United States, has become a familiar sight in daily railway trains; and the new

* The diagram on the opposite page exhibits profiles of the main lines of the Mexican railroads named below, and one branch road, to show the general topography as affecting avenues of communication:

The Mexican railroad (standard gage) follows a general easterly course from the city of Mexico to Vera Cruz (263 miles), the highest elevation reached being 8225 feet, the termini having heights respectively of 7350 feet and zero.

The Interoceanic railroad (narrow gage) also starts at the city of Mexico and pursues the same general direction to Vera Cruz, the distance between the termini being 342 miles. It reaches an elevation of 8067 feet. As the distance between the capital and Vera Cruz is greater by this railroad than by the Mexican railway, two locations for Vera Cruz are given in the chart.

The Mexican National railroad (narrow gage) extends in a northerly direction from the city of Mexico to Nuevo-Laredo (839 miles), at the Rio Grande boundary between the United States and Mexico, opposite Laredo, Texas. The highest elevation reached is 10,020 feet.

The Mexican Central railroad (standard gage) runs from the city of Mexico to Cuidad Juarez, also at the national boundary opposite El Paso, Texas,—a distance of 1224 miles. The greatest height reached is 8045 feet. This railway is shown by a full line, as is also a branch line connecting Aguas Calientes, on the main road, with Tampico. This branch is 415 miles long, but to keep the diagram distinct only 275 miles from San Luis Potosi to Tampico are represented.

The Mexican International railroad (standard gage) is completed from Ciudad Porfirio Diaz (opposite Eagle Pass, Texas), to Durango (540 miles), crossing the Mexican Central railroad at Torreon. The exploited coal deposits referred to by Mr. Robert T. Hill are in the vicinity of Sabinas on this road. The road at one point reaches an altitude of 6503 feet, the general direction followed being southwesterly.

The profile of the Monterey and Mexican Gulf railroad (standard gage) is incomplete, data for a few prominent points only being accessible. It extends in a general north-northwest direction from Tampico (387 miles), crossing the Mexican National railroad at Monterey, and connecting with the Mexican International at Trevino, the present terminus. The greatest height reached is at Trevino, 2920 feet. To show the proper connection of this railroad with the Mexican International railroad, Monterey is indicated in a different position from that designated on the Mexican National railroad. A similar duplication of the stations at Celaya is indicated on the Mexican Central and Mexican National railroads, these two railways crossing at this point, and Tampico is shown in its proper relation to different connecting points.

The Sonora railroad (standard gage) has a southern course from Nogales, on the Arizona border, to Guaymas, on the Gulf of California, a distance of 265 miles. The highest point reached is at Encino, 4284 feet.

conquest of Mexico by the engineer is an accepted fact. . . . Of the tracks of railroads in the republic of Mexico the altitudes are as follows:

Above Sea-Level.	Proportion.
Less than 1000 feet	15 per cent.
Between 1000 and 2000 feet	10 per cent.
Between 2000 and 3000 feet	6 per cent.
Between 3000 and 4000 feet	10 per cent.
Between 4000 and 5000 feet	13 per cent.
Between 5000 and 6000 feet	15 per cent.
Between 6000 and 7000 feet	15 per cent.
Between 7000 and 8000 feet	13 per cent.
Between 8000 and 10,000 feet	3 per cent.

To summarize this table, three-fourths of the entire railroad mileage in Mexico is at elevations greater than are reached by any of the Pennsylvania railroads, and about one-half of the Mexican tracks are below, and one-half above, a level of 5000 feet; of the higher portions some 200 miles are laid from 8000 to slightly over 10,000 feet above sea-level.

Of twenty Mexican cities which in 1890 had populations exceeding 20,000, all but two are located at elevations between 5000 and 8000 feet above the ocean level. Owing to the topographical features referred to, most industries to be successful in Mexico should be located at or near sea-level, or on the great plateau at elevations of from 5000 to 8000 feet above tide.

The great cost of the Mexican railroad from Vera Cruz to the city of Mexico, the difficult and expensive work on the Interoceanic (narrow-gage) railroad between the same termini, as well as upon the branch of the Mexican Central railroad from Aguas Calientes to Tampico, illustrate the character of natural barriers to be overcome in reaching the great plateau from the coasts. This is further shown by a study upon railroads from Guadalajara to the Pacific coast by S. V. Pascal,* in which the author describes three proposed routes, respectively 216, 269, and 250 miles in length, with 2, 2½, and 3 per cent. grades, which he estimates will cost for construction from $40,000 to $44,000 per mile, independent of the right of way, stations, plans, and supervision.

The fuel problem in Mexico demands serious consideration. Mr. Robert T. Hill, in a paper on "Mexico as an Iron Producing Country,"† refers to the coal-mines which are wrought in the northern part of the republic. A map accompanying his contribution shows graphically that all of the present developed coal-fields are far removed from most of the centers of population. In addition

*Transactions American Society of Civil Engineers, Vol. XXIX.

†The Engineering Magazine, February, 1893, pp. 744-753.

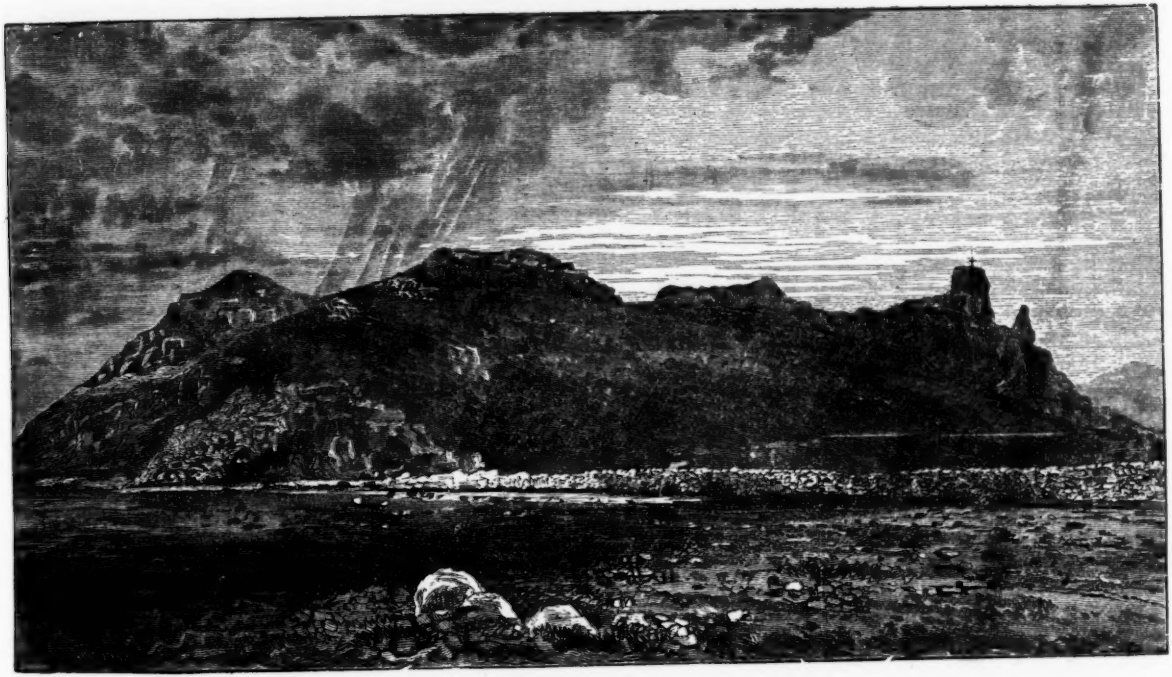
to the distances to be overcome, the fact that the most productive coal deposits are located at an elevation of but 1000 feet above tide, while the bulk of consumption is at elevations between 5000 and 8000 feet, affects the practical application of that fuel to a considerable degree. The numerous reported discoveries of coal elsewhere either have been insufficiently exploited, proved to be of inferior quality, or are now inaccessible even for thorough investigation, so that practically the entire dependence of the republic is upon the northern coal-fields, or upon coal imported from the United States or Europe. It is probable that subsequently exploited coal deposits will be at locations demanding that their product be hauled up steep grades or over considerable distances to reach the main plateau. English bituminous coal delivered in the city of Mexico in April, 1893, cost $17 in Mexican money, per metric ton, and Alabama (United States) bituminous coal cost $21. Coahuila coal cost, delivered in Puebla, $26 per ton.

Except in the mountain fastnesses, or in territory which, with existing methods of transportation, has been practically inaccessible, the scarcity of wood restricts its employment in industries. In the hot lands much of the timber growth is of classes too valuable to use for fuel or of inferior calorific importance.

A nation which, within the limit of an average human life, has had such varied forms of government, so many internal dissensions, and so little encouragement to develop its manufactures, can hardly be expected to have capital in excess, but must naturally look to other countries for money to assist in its material advancement. The problem of establishing Mexican industries, therefore, is beset by financial difficulties greater than are to be found in some other nations. The recent railway development has shown, however, that foreign capitalists have had no little faith in the future of the republic, for they have invested more than $100,000,000 in these enterprises, in addition to large sums in its industries.

Long droughts, intensified by the general absence of perennial snows, followed by intermittent and heavy rain-falls, are not conducive to the location of industrial centers, except where these conditions are modified by such natural or artificial facilities as improve the permanence of the water-supply. The hygrometric conditions which prevail over a large part of Mexico may be summarized in the above statement.

The foregoing considerations being applicable in whole or in part to all manufactures, it is now proposed briefly to consider them



THE CERRO DE MERCADO (IRON MOUNTAIN) AT DURANGO, MEXICO.

[From Transactions of the American Institute of Mining Engineers.]

in relation to the production of iron, supplementing the admirable article in THE ENGINEERING MAGAZINE of February, 1893. This article refers to various Mexican iron-ore deposits, and additions to this list could be furnished to show the extent and variety of accessible ores. Such detail, however, is not essential for present purposes, but it appears proper in this connection to state that a recent visit to the Cerro de Mercado at Durango confirms the opinion which I expressed in 1882, and which is quoted in Mr. Hill's contribution, that this is the largest visible known deposit of iron ore. I do not coincide, however, with the view expressed that most of the Mexican iron-ore deposits are analogous to those of the Cerro de Mercado and Monclova, for some of those which have been personally examined vary in physical structure and chemical composition, and differ mineralogically and geologically from the Durango and Monclova ores. While there is no lack of iron-ores, many of which are of a satisfactory character, the use of these will depend upon the facility with which they can be assembled at points where fuel is sufficiently abundant and cheap, and from which manufactures can be distributed advantageously. The abundance of limestone in Mexico makes the supply of suitable flux an easy problem for a number of available furnace sites.

The most modern iron-producing plant in Mexico is at Durango, where the ore problem is readily solved, the furnace being under the shadow of the great mountain of ore, but the nearest known supply of coal is 450 miles distant, at a level 5000 feet below Durango, while for smelting purposes its quality is open to criticism. To obtain wood or charcoal of satisfactory quality in sufficient quantity it will be necessary to convey these 40 miles to Durango, constructing a railway for the purpose. Up to the present time fuel of this character has been obtained nearer, at scattered locations, and brought in by *burros* and *carretas*. Another apparent drawback to the Durango location is its distance from a population which could consume a large portion of its products, and yet with these disadvantages an iron industry should be operated successfully in this locality in competition with imported materials on which duties have to be paid.

The other active iron industries of Mexico consist of less modern structures, located generally in closer proximity to the bulk of the population, and several are convenient to excellent ores and an abundance of wood. But these sites in the heart of the mountains demand expensive and troublesome transportation to reach a mar-

ket. Several of the smelting-plants have rolling-mills and foundries attached, but in most cases castings are made directly from the furnace, the molten metal being ladled from a fore-hearth; in one case a steel-works is in course of construction. A number of foundries are located in the cities, using scrap iron principally, with imported pig-metal, and there are also independent rolling-mills and wire nail-works, the latter using imported bars.

In several foundries and machine shops visited by the writer most of the employés were Mexicans, and an inspection of their work on lathe, planer, or drill-press, at the vice, forge, or pattern-bench, demonstrated a natural ability requiring only cultivation to develop mechanics. While the ordinary wage rate is low, skilled help commands prices equalling and sometimes exceeding those prevailing in the United States for similar work.

The policy of the Mexican government has been to protect its industries, and this policy is likely to continue if sufficient advancement is made to warrant governmental support. By far the larger portion of the manufactured iron and steel which has been used in Mexico is of foreign production, concessions having been made which permitted most of the railroad companies to import duty free all materials necessary for the construction, maintenance, and operation of their roads. These requirements can be interpreted to cover nearly every kind of manufactured iron and steel and machinery, but the concessions are limited as to time, and the progress of the domestic industries probably will influence extensions of these privileges. From what has been stated concerning the conditions which influence the establishment of industries in Mexico, there would appear to be an advantage for selecting sites for iron manufacture upon the higher lands and within as short a distance as possible from the consuming population. The product of works so placed would have, in addition to any protection offered by the government, a further protection from foreign-made material which, after being transported by water, must be raised by steep gradients on railroads which consume expensive imported fuel. The cost of carrying coal, and in many cases water, to supply the motive power, must have the effect of maintaining high freight rates if the railways are to earn a profit. The prices for iron prevailing in the spring of 1893 in the city of Mexico were: Bar iron, ordinary sizes, 8 to 12 centavos per pound; ordinary castings, 10 to 12 centavos; nails, 12 to 14 centavos per pound.

The demand for iron and steel in Mexico embraces practically

most of the products and manufactures required elsewhere. The railways will be extended, but their immediate development will be confined principally to feeders for existing lines, for the policy of the government will hardly favor further subventions except for roads of special importance. Such extensions, together with track-renewals and sidings on existing lines, will require considerable quantities of rails, spikes, bolts, and metal ties (the latter being preferred on several Mexican lines), while locomotives, cars, wheels, couplings, etc., will demand renewals and reconstruction.

In view of the scarcity of metallurgical fuel and the necessity of producing steel on a liberal scale to secure economic results, it is probable that rails for Mexican roads will continue to be imported, and especial advantages possessed by large industries confined to the manufacture of locomotives will interfere with the construction of these in Mexico. But with the concessions removed which have permitted the free entry of other railroad material, there is a good opportunity for home production. The manufacture of structural iron seems to offer a good field where long or heavy timber is expensive, and it is probable that the moderate climate will encourage the continued use of iron grillings for windows. Nails, sheet metal, and merchant iron and steel also suggest profitable ventures for industries well located and managed.

The superiority and cheapness of Mexican earthenware and the use of open fires must to a considerable extent interfere with the employment of iron household utensils, while the necessity for stoves will not appeal forcibly to natives to whom the sudden but generally moderate changes of temperature cause little discomfort. But there is a demand for stoves and hollow-ware, which will increase as their use is appreciated and mineral fuel becomes more accessible. The public supply of water under pressure is supplanting the aqueducts and open *acequas*, and municipalities will need iron water-pipe, special castings, and hydrants. Mines will also demand conduits for water and machinery, but much of the latter will be obtained best from manufacturers who make this a specialty. Wagon-tires, axles, agricultural implements, and machinery will gradually replace the cruder appliances in common use.

The abundance and cheapness of labor, while offering advantages for securing workmen, emphasizes the fact that a large proportion of the population of Mexico can be looked upon as purchasers of but little of the manufactured products until these can be offered at prices much below those now prevailing, and the distances

to be covered in distributing the articles must add to their cost to the consumer.

Mr. A. Falkenau, who visted Mexico to study the opportunities for opening a trade in mining machinery, says: "American engineers have charged that the only reason preventing the introduction of machinery is the absurd reverence in which the Mexican holds the customs and manners of Montezuma's time. . . . There is no doubt some foundation for this charge, but upon closer investigation I became convinced that a great injustice is done to Mexicans. The true key to the cause of their opposition to the introduction is to be found only by a study of the topography, the natural resources, and the political condition of the country."

In presenting my convictions concerning the extension of the iron industry in Mexico, I am far from desiring to minimize the resources of the country, or to discount the probability of their utilization. A territory rich in minerals, peopled by a race who are really industrious, living in a climate which enraptures most visitors and which encourages a luxurious vegetation, must prosper under enlightened progressive leadership and increased educational advantages. Such prosperity will come more quickly when advances are made with a knowledge of conditions as they exist, than if enterprises started upon wrong ideas convey this knowledge through disastrous failure.

The romances of the fabulous wealth of the Aztecs and the millions of bullion lying in waste-piles in old mines have led to investments which have brought injury to Mexico. The labor which for a few centavos per day will "dog-hole" a mineral deposit and inspect each individual piece of ore is not of the sort to throw much treasure on dump-piles. In some cases modern methods of extraction may permit the recovery of what was formerly wasted, but as a rule mining in Mexico is the same as elsewhere,—profitable only when well planned and efficiently managed. The climate of the low country favors the growth of cotton, coffee, and sugar; the elevated grazing grounds will support herds and flocks from which hides and wool can be gathered, and these, together with other products, can be manufactured where a consuming population is easy of access. Under intelligent administration, diffused education, improved methods, and common-sense practice the wealth of Mexico will excel the fabled glory of the Montezumas. But he who expects this wealth to drop from the heavens as generously as meteoric stones were showered upon Mexico will reap only disappointment.

ROAD-BUILDING IN A SOUTHERN STATE.

By D. A. Tompkins.

THE question of good roads is not one of construction alone, but of development and maintenance as well. The first settlers of the various American States were unable to spend much money or labor in road-making, but had to be content with clearing away the forest from a strip of ground twenty or thirty feet wide, which they called a road. In sparsely-settled counties in some States to-day this simple method of opening a way through a forest, at a cost of from $20 to $100 per mile, may be a heavier burden upon the community than the construction of a line of railway in some other section at a cost of $50,000 per mile. Between these limits of expenditure discretion must be exercised as to the best kind of road that the amount and character of traffic will warrant.

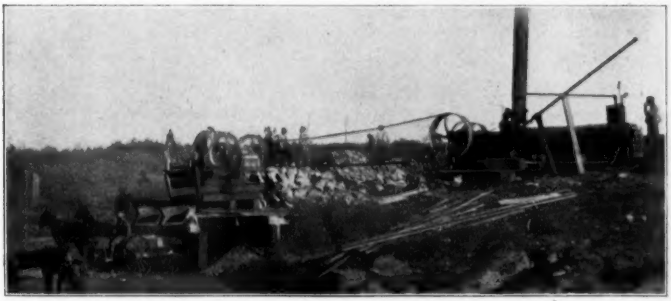
Since most inhabitable places have become supplied with roads of some sort, questions of original construction will not come before the road engineer as often as plans for improvement. Assuming that a given community has reached that condition of development where its traffic has become important in volume and value, while its roads have been growing impassable through bad usage,—for this is generally the condition of things that excites interest in the road question,—what is to be done? The question is too broad to permit of any answer that will be generally applicable, so various are the conditions of topography, the materials available, the amount of road funds, the state of the roads to be improved, and the character of the traffic. Nowhere else, perhaps, is the need of improved highways more pressing than in some of the southern States, and it has occurred to the writer that some of the readers of the Magazine might be interested in an account of the success of a practical experiment in the betterment of roads in his own State—North Carolina,—which may be assumed to be fairly typical of this section of the Union. This choice of a State for treatment in this connection may be all the more proper for the reason that of late the holding of "road congresses" has been begun in North Carolina, as the outgrowth of which we may expect that the work of improvement, so satisfactorily commenced in a few localities, may spread

over all the neighboring counties. By the way, the utility of such conventions, as a means of concentrating the attention of the public upon questions of road improvement, may commend itself to the friends of the cause in other States.

It is important at the outset to consider that the highway alone does not afford a means of transportation, but the road and vehicles combined. Hence, in the construction of either a road or a vehicle, regard should be had for its effect upon the other ; neither should be formed in such a manner as to destroy the other. The

ROAD-BUILDING IN A SOUTHERN STATE—STRAIGHTENING AND GRADING.

sole of the human foot is broad enough to pack the soil into a hard, smooth surface, so that usage, instead of destroying a footpath, commonly improves it. The old Indian trails, developed by this means alone, were for the uses of the Indian a far better highway than the average modern road is for the people who travel upon it. Most of our roads have been cut up by narrow-tired wheels, which soon produce ruts the bottoms of which are the most compact part of the road. In such ruts the wide tire wedges in be-



ROAD-BUILDING IN A SOUTHERN STATE—CONVICTS PREPARING MACADAM.

tween the sides, making the broad tired wheel pull heavy. The narrow tire, on the other hand, cuts most easily through the soft mud to the bottom, not wedging on the sides, and therefore pulls lightest. Consequently the mistaken conviction prevails in places that the narrow tire is the better one, though its easy pulling applies only on roads which have been cut up by the vehicle itself. But if broad tires had always been used, the point of contact of the vehicle with the road covering enough surface to make the vehicle pack the track it passed over, the result of usage might have been constant improvement of the road. There are, of course, soils too soft to support tires of any practicable width, making necessary artificial road-beds, of which more hereafter.

ROAD-BUILDING IN A SOUTHERN STATE—CONVICTS DISTRIBUTING STONE.

ROAD-BUILDING IN A SOUTHERN STATE—THE COMPLETED ROADWAY.

But to recount the North Carolina experiment. About fifteen years ago the mayor of the city of Charlotte* inaugurated a movement to have the streets, which up to that time had been clay roads, macadamized. The plan adopted was to have stone broken by hand and laid on the streets to a depth of six or eight inches, after making an equivalent excavation. With an expenditure of $25,000 about five miles of streets were put into fair order. The work was continued under successive administrations, with a continual improvement in methods, and the city now owns a well-equipped rock-crushing plant, the crushing of rock by hand having been abandoned.

As the street building in Charlotte increased, the authorities of Mecklenburg county took up the subject of improving the highways outside of the city. The first important step was to secure from the State legislature authority to levy a road-tax of from 7 to 20

*The incumbent of the office then was William Johnston. Subsequently, under the administrations of W. C. Maxwell and F. B. McDowell, considerable work was done. The present mayor, Dr. R. J. Brevard, has done more work in street improvement than any of his predecessors. D. A. T.

ROAD-BUILDING IN A SOUTHERN STATE—THE OLD ROAD AND THE NEW.

ROAD-BUILDING IN A SOUTHERN STATE—A COUNTY CONVICT CAMP.

mills on $100 worth of the taxable valuation. The rate at present levied is about 15 mills, which yields some $36,000 a year.

Next the passage was secured of a law authorizing the county commissioners to take charge of all convicts sentenced by the city and county courts, the punishment for many offenses being a fine or so many days' work on the public roads. It is the belief in this county that this is the best possible disposition than can be made of the convicts, as they are not then brought into direct competition with honest, free labor, while their work inures to the direct benefit of the public.

The work of building, reconstructing, and repairing streets and roads in Mecklenburg is now in progress in three departments :

I. In the city of Charlotte, under the direction of the city council, by the mayor, city engineer, and supervisor of the streets. The work is paid for out of the city treasury.

II. The county at large, under the direction of the county commissioners,—a board of five, elected annually by a vote of all the magistrates in the county,—by the county engineer and the superintendent of the convict camp. Half the proceeds of the road-tax is disbursed by this board.

III. Each township, through its board of trustees, expends for local work in road-building one-half the proceeds of the road-tax raised within the township.

The city, the county board, and Charlotte township each own a plant, including a portable boiler, a slide-valve engine, a rock-crusher, a roller, and a screen made of boiler-plate perforated to separate the broken stone into three sizes, the largest being about 1½ inches square. In practice, the coarser stone is laid on the bottom to a depth of four inches ; the second size is laid next, three inches thick, and the fine stuff is used for a top-dressing of about two inches. Each of the three layers is well rolled as laid. The stone used in macadamizing is mostly furnished by the farmers after they have finished cultivating their crops. The price paid to them is 50 cents per cubic yard. The rock is delivered by them and stacked up at convenient points on the roads.

The work of the county commissioners, with convict labor, is the most interesting feature of all, and will be described more in detail. Originally the work done was the rounding up of the road-bed, cutting drainage-ditches, and excavating the center of them to a width of twelve feet and a depth of nine inches, the space to be filled with stone broken by hand. The system has now been developed

until not only is the stone broken by steam-power, but roads are relocated, graded, and become practically new roads.

In Figure 1 is shown a cross-section of road-bed as constructed during the past year. It has been noticed that when the roads are

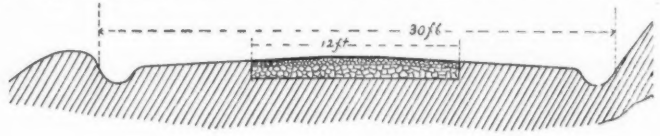


FIG. 1.

dry the clay road-bed is preferred by all drivers, and the location of the macadam in the middle of the road leaves either side too narrow for vehicles. Hence, in attempting to use the clay bed, the wheels of one side of a vehicle are always in the drainage-ditch, which spoils it. Now it is proposed to construct the road-beds as in Figure 2, omitting the paved gutters except where absolutely necessary. On this road-bed the macadam way can be used in the winter season and the clay road in summer. Besides the greater comfort of driving over the clay in summer, the macadam is protected from the unnecessary wear and tear of summer traffic.

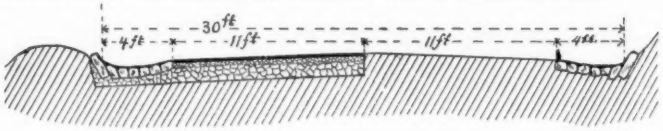


FIG. 2.

The use has been suggested of an iron roadway, as shown in Figure 3. It would be similar in form to a street-railway track, except that the rails are so shaped as to receive the wheels of vehicles of different widths. The section of the road between the rails would be macadamized, and the rule might be adopted of giving the loaded wagon right of way. A suggestion made by Mr. L. D. Ramsey, of Raleigh, N. C., is illustrated in Figure 4. He estimates that a roadway may be covered about as cheaply as it can be macadamized. The advantages claimed are of keeping the road-bed

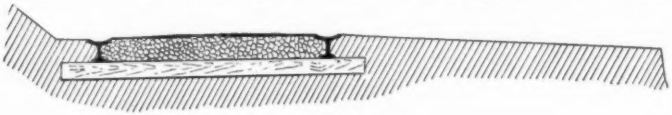


FIG. 3.

dry and of protecting travelers from storm and sunshine. The other illustrations accompanying this paper are made from photographic views of work in progress on the highways, designed to indicate the character of the improvement made.

The result of the work outlined here has been to lift Charlotte out of the mud and to make it a city of very clean streets and attractive appearance. In the county it has greatly increased the accessibility of markets to the farmers, besides furnishing attractive drives for the people of both city and country. All this has been brought about within a few years, without any appreciable burdens upon the people, in a section where, from time immemorial, the road-beds might have been compared to the tempering-pits in a brickyard.

The reports of the county engineer and the superintendent of county work show that the cost of feeding, clothing, and guarding convicts during the first five months of 1893 amounted to 20½ cents per day, the average number cared for being 91 per month. The report for June shows the cost per convict for each day *actually worked* to have been 31¾ cents. During the first nine months of that year an average of 90 convicts per month moved 36,247 cubic yards of earth on the roads, and crushed and placed 7381 lineal yards (4⅕ miles) of macadam, twelve feet wide. Five bridges were built or repaired during the same time. The total cost of the camp during nine months, including salaries, machinery account, and material, was $14,076.52. The last monthly report shows no convicts on the sick-list, and no escapes during the month. The convict camp is moved three or four times a year. In summer canvas tents are used. In winter the sides of the barracks are boarded up, leaving only the cover of canvas.

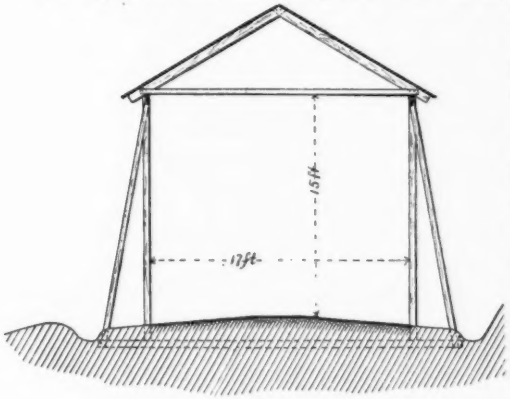


FIG. 4.

In Mecklenburg county it is considered important to avoid small wooden bridges, and to use terra-cotta drains instead. It is also believed that a depth of five inches of macadam would give as good service as the nine inches now used, if broad-tired vehicles were insisted upon and needed repairs were made upon the first appearance of a break. It is probable that the weakest point in the Mecklenburg system of road-making is in the matter of drainage.

The aim of the road commissioners has been to make all the available money go as far as possible toward giving better roads to the largest number of people possible, and to do the work in such a manner that the roads may be still further improved in future. To this end, the point has been made to perfect plans in every case before commencing work. The county now has about forty miles of reconstructed and macadamized roads. The total cost has ranged from $2700 to $4000 per mile, according to the amount and character of grading required. The value of the work to the farmers may be judged from the statement of Mr. B. H. Moore, one of the county commissioners, before the road congress at Raleigh. He said that before the roads were macadamized there were times when a pair of large mules could not draw a load of more than 1000 pounds from his farm into the city, whereas now they can, at any season, draw from 2500 to 3500 pounds. "The question now with us," he said, "is not what the team can draw, but what the wagon will hold up."

SMALL ELECTRIC-LIGHT STATIONS.

By J. E. Talbot.

THE business of electric lighting, in its commercial aspect and from the point of view of the central-station manager or owner, has been hitherto for the most part involved in mystery. Those who have made and who continue to make money desire, evidently, to confine their painfully-acquired knowledge to the esoteric few, while, on the other hand, those whose experience has been of a different character prefer to maintain a modest and discreet reticence on the subject. Thus, it has been difficult in the past for intending investors in this class of work to obtain unbiassed and trustworthy information.

Generally it has been impossible for two or three persons to discuss together the practicability of establishing an electric-light installation of moderate size without having let loose upon them a small army of the interesting and active promoter known as the "electric-light-man." These salesmen, almost invariably of a genial and hospitable turn of mind, usually make things "hum" locally, for a time, and when (if indeed the proposed investors have strength of mind left to postpone any definite action) their missionary efforts are ended, the promoters of the contemplated enterprise discover that they have added to their list of pleasant acquaintances and to their stock of good stories, but that their knowledge of electric-lighting matters, instead of being a simple *zero*, has now become a *minus* quantity.

Now, it is a curious condition that each of these representatives of competing, or ostensibly competing, companies, really does believe the system he represents to be the best in the world, and he acts according to his faith, if not beyond it, and here arises one of the difficulties that intending purchasers have to meet. This trouble is the tendency of every selling-agent to "go" the other fellow "one better." If A says that his machine will operate 500 lights, B says his apparatus, although designed for 550, will be perfectly good for 600, and so on, and it will be strange indeed if A, being thus challenged, does not rise to the occasion. Then the boiler-men and engine-men will have their innings, and, under competition, will cut their prices also (and quality at the same time) until, as the total result, the purchasers eventually start with

a crippled plant—dynamos too small, engine- and boiler-capacity too small, and the quality of neither what it ought to be. By this time, moreover, the purchasers probably will have discovered that their plant is in a fair way to cost more than the amount originally believed to be sufficient. This means reduction in construction-expenses, poor poles, low-priced wire, and poor work,—all in the end expensive.

The results of this method of procedure are before long apparrent in engine troubles, burnt-out armatures, hot boxes, grounded circuits, interruption of service, customers' complaints, and consequent loss of revenue. This condition of affairs rapidly produces a general distrust of the whole field of electric work,—a condition to be deplored, not only from the point of view of the manufacturer or exploiter of electrical apparatus, but also from that of the purchaser, who thus becomes unnecessarily deprived of and disgusted with an agency capable of providing him with light, heat, and power in various convenient forms and methods of application not otherwise available to him.

It would be easy to dilate on the various annoyances and troubles arising from the causes adverted to, but they are so familiar to all who have any experience in this field that it seems unnecessary to do so here. A more important matter would seem to be the pointing out of a remedy for, or rather some preventive measure against, the occurrence of such conditions.

When an electric installation is proposed it is well, if possible, to obtain the services of some one not suspected of having an alliance with any particular manufacturing company, and one who has had practical experience in the direction of the work required, —not selecting a telephone-man, for example, to advise on a question of power-transmission. In past years it has been difficult to obtain competent expert advice outside the staffs of the large manufacturing companies. This is not now the case, however, for some of the best men in the profession are now acting independently of any such connection. But however desirable it may be to procure the best of advice, there are certain points on which some general suggestions may be of value, independently of specific advice relating to particular cases.

It is somewhat difficult to formulate any definite set of questions or points which should be absolutely decided before engaging in an investment of this nature,—an investment which in the end may be not only fairly remunerative, but extremely so. There are, at

the same time, as already intimated, certain essential and primary matters needing careful attention before such a desirable result can be anticipated. These are :

1. Cost of real estate.
2. Cost of building.
3. Cost of power (water or steam) plant.
4. Cost of electrical apparatus.
5. Cost of outside construction, to include pole-line and labor on same, wire and stringing same, hanging arc-lamps, and setting converters, if used.
6. Cost of inside wiring.

The first two items depend so largely upon local conditions of price of real estate and building materials that it is scarcely possible to make any intelligible statement in regard to them ; they are further dependent as to their amount on items 3 and 4. These must, therefore, be left in abeyance. Item 3 is also dependent on item 4, which, indeed, must always be the final criterion for the whole plant. It will be necessary to a proper decision of this portion of the subject, therefore, to assume some specific capacity of plant.

Suppose that a certain town should require 50 to 60 arc lights for public uses, and about 1200 incandescent lights for commercial purposes, such as the lighting of stores, hotels, and residences. The cost of the electrical apparatus for such a station, installed complete, including the arc-lamps, should amount to about $4500 for the arc-lighting, and to about $2500 for the incandescent, for high-class apparatus. The steam-plant, not allowing for any considerable increase, but based on the full electrical load—say 150 horse-power—would closely approach the sum of $5000.

The sum allowed for the construction of the outside lines, such as setting poles, stringing wire, hanging the arc-lamps, and placing converters, would vary considerably in different places and under different local conditions. Some general suggestions may be offered, however: For arc circuits about $140 per mile of running wire and running same—using No. 6 B. & S. good weather-proof wire—may be allowed, and for the construction of the pole-line, hauling and setting and gaining poles, placing cross-arms, pins, and insulators, under ordinary conditions, about $160 to $175 per mile is a fair estimate. The primary circuits for an alternating system are dependent on matters other than the mere length of wire used, and in large cities must be calculated carefully and

definitely. But in a town of the size under consideration, for the wire and stringing, and the necessary additional cross-arms, pins, etc., assuming that the same poles can be used as for the arc circuits, $1000 should be sufficient. The inside wiring,—that extending from the converters to the lamps,—ought not to exceed, including the lamp and socket, $2.50 per light of 16 candle-power, for plain work. For concealed or special work a larger amount probably would have to be allowed. The cost of converters would be from $1 to $1.50 per 16 candle-power lamp-capacity.

It will thus be found that for a plant of the size suggested, which would not be unsuitable for a town of 5000 to 10,000 inhabitants, the promoters would have to reckon on an expenditure of capital, practically in the form of cash payments, amounting to some $17,000, as follows:

Steam-plant of 150 H.-P., including foundations, stack, piping, belting, etc.	$5,000
Electrical apparatus in station, including arc-lamps, instruments, switch-boards, etc.	7,000
Arc circuit, complete, to include poles, wire, hanging of lamps, etc., on the basis of, say, 8 miles of wire, and 5 miles of pole-line	2,000
Incandescent circuit, primary, utilizing arc-light poles	1,000
Converters for 500-light capacity, leaving balance to be purchased as needed	625
Wiring up, with plain wiring—500 lights—to include lamps and sockets	1,250
Total, excluding real estate and buildings	$16,875

It will be seen that no consideration is here had of the direct-current system for the incandescent lighting. In a town of the character considered, with the direct-current or low-tension system either an impracticably large amount of money for the necessary conductors would have to be expended, or parts of the town area would have to remain without service. The business in such a place is necessarily of a scattered nature, while the low-tension direct system is more especially adapted to localities in which a large and remunerative amount of work can be obtained within a comparatively short distance from the station. This class of work would more properly be considered with reference to the conditions obtaining in a large city.

There are many other considerations in regard to which the central-station manager of a large plant must give careful and anxious thought, such as the kind and quality of fuel, the comparative merits of large or small units of power, the desirability (or the opposite) of direct-coupled dynamos; these, however, do not

properly come within the scope of a few general hints on small stations. The question of the utilization of the plant during daylight by means of a power-service is also one which usually does not arise in connection with these small plants.

It may be thought that the writer is a special advocate of these small electric-lighting stations, but this is not the case; unless they are designed and laid out with a view to, and capacity for, rapid and easy extension to meet the demands of the future it is the exception to find them remunerative to a high degree. In many cases, however, they serve to obtain possession of a field for business which in growing towns may rapidly become valuable. But too frequently the projectors disregard these considerations, and the above figures indicate rather the amount of money that such stations *do* cost than the amount that a station laid out on proper lines *ought* to cost. At any rate it is hoped that the figures may prove to be of some value,—if not as a guide, then as a warning.

Having estimated the expenditure of capital necessary in the first installation of the plant, the most pertinent matter of enquiry is with regard to the *cost of operation*, as compared with the *total earnings*. It is to be regretted that data of this nature are somewhat reluctantly furnished, but the reason is not hard to understand. Those companies which have been fortunate enough to secure what is colloquially known as a "soft snap" keep their information to themselves to avoid any reduction of the rates that the traffic will bear, while those who have lost money by such an investment do not care to expose what might be considered a want of business acumen.

It is believed that the following figures may be taken as approximately correct, with certain reservations to be adverted to hereafter. Estimates based on general assumptions which are believed to be fair and not unusual will first be given, and certain modifications and corrections to be considered will be dealt with subsequently by way of explanation. The question of revenue is at any rate the more interesting of the two and will be considered first, although it might be thought by some more proper to consider first the cost of operation.

It should be understood that the figure of $85 per annum for arc lights of nominal 2000 candle-power, burning from dark to midnight, is not entirely arbitrary. It is estimated as an average figure under conditions such as those here assumed. Actual prices range all the way from $60 to $200, under varying circumstances:

REVENUE.

Revenue from 50 arc-lamps, lighted each night from dark until midnight, under contract with city at $85 per lamp per year	$4,250
Revenue from incandescent lighting, say *average* load of 500 lamps of 16 C.-P. each, for *average* time of 4 hours per night, taken throughout the year = 2000 lamp-hours per night × 365 = 730,000 lamp-hours per annum, at 1 cent per lamp-hour	7,300
Total	$11,550

OPERATING EXPENSES.

Labor—First engineer	$960	
Second engineer or fireman	600	
Lamp-trimmer and general man	600	$2,160
Fuel (estimated at 750 tons of coal at $2.75)		2,062
Carbons for arc-lamps		500
Incandescent-lamp renewals		600
Taxes and insurance		600
Collections, bookkeeping, stationery, etc		500
Oil and waste		260
Repairs, ordinary		200
Allowance for depreciation (say 7½ % on $12,000)		900
Contingencies and sundries		100
Total		$7,882

Deducting from $11,550 the sum of $7882, we have an apparent profit of $3668, which, as times go, is a very good percentage (about 14½ per cent.) on $25,000, assuming that the total cost of the plant approximates that figure. Now, what are the contingencies which may, and too frequently do, reduce this apparent profit? It will be obvious that these may take the form either of excessive expenditure or of deficient returns.

Excessive expenditure may arise from an excessive consumption of fuel, due to poor quality, careless firing, improper condition of the furnaces or boilers or engines, or of the dynamos or circuits, it being taken for granted that the apparatus was in good condition to start with. A good fireman ought to know how to fire, and if he does not the engineer should show him. Boilers should be cleaned regularly, and engine-valves and all other apparatus overhauled and examined at suitable intervals. Hot boxes should never be allowed. All parts should be kept scrupulously clean, and the circuits kept free from grounds. On the incandescent circuits as few and as large transformers as possible should be used, and also lamps of as high an efficiency as is consistent with a reasonably

long life. The current on the arc circuit should not be allowed to exceed the standard, nor should the pressure on the incandescent circuit exceed that required to operate the lamps at their rated voltage to deliver their proper candle-power. Care, or the reverse, in this direction most materially affects the coal-pile. The item of oil, with careless men, frequently assumes alarming proportions.

Large and unnecessary repairs may generally be avoided by foresight in the outset. A little false economy in the installation results in continual repairs to all parts of the plant, from the building itself down to the lamps furnishing the light, not only under the head now being considered, but also by reason of reduced revenues by rebates for defective or interrupted service.

If the lights are extinguished at midnight an economy can be effected in the use of the arc-carbons, the unconsumed portion of the upper carbon (the longer) being often sufficient for another night's run, if used as a lower carbon. The use of double-carbon lamps will also be found desirable in this direction, as one trimming of the lamp often will serve for two nights, especially in the summer, thus either reducing the wages of the trimmer, or enabling him to assist in other work on the lines or around the station.

These considerations should be known to the man in charge of the plant. But too often they are overlooked, and it is poor economy not to have at least one good man in charge, and a matter of $50 or $100 a year in the pay of that man may be lost or saved many times over in the course of twelve months. After all, "the best system is the man who runs it."

Deficient returns are due, as to the city arc-lighting, simply to deductions from the bill on account of lamps not burning. A condition of this kind is frequently imposed upon the lighting company, and these deductions not seldom amount to a considerable sum. But if the station apparatus and lines have been installed properly and cared for, there is hardly any excuse for a complete shut-down. The trouble is due usually to careless trimming of some of the lamps, for which the trimmer should be called to account.

Another and more serious difficulty, which applies to incandescent lighting, is that possibly the rate assumed in our table cannot be obtained at all. This may be due simply to prejudice, or to the competition of artificial or natural gas. Kerosene can hardly be considered as a competitor.

The rate of one cent per lamp per hour is the usual standard

rate, whether under contract or measured by meter. Sometimes, in making rates, a reduction has to be made for a customer who takes a large number of lights, and in the case of both contract and meter rates a discount is often allowed for prompt payment. Interruptions of service, too, give rise to claims for rebates which cannot always be resisted, though they should invariably be scrutinized with care. The writer remembers a case where a claim was made by a customer that his store was in darkness, and it appeared that he had omitted to turn his switch controlling the lights!

Claims for new incandescent lamps are often made. In such cases stubs of the old lamps should always be returned to the station before new lamps are issued, (1) because the lamp-factories will allow a few cents for each stub, and (2) for the reason that lamps are sometimes stolen and sold, and new lamps claimed to replace them. A customer who *breaks* a lamp should be charged full price, renewals of lamps burnt out being made by the company.

Bad debts are contingencies which must be taken into account in estimating profits. The item of water for the boilers was designedly omitted from the estimate of operating expenses. It should not be a very large one in any event, but, in locating a station, wherever possible advantage will be taken of natural conditions, and it frequently will be practicable to select a situation where water can be obtained for nothing or at a moderate cost by sinking a well, that cost being added to the capital expenditure. If water has to be purchased, the amount must be added to operating expenses.

The cost of coal varies enormously with different localities; the writer is familiar with lighting-stations where good steam coal is delivered in the station for 70 cents and 80 cents a ton (practically the cost of hauling), while at others $5 and $6 has to be paid. The estimated figures given above must be modified to correspond with the actual price. The high price of coal is usually to some extent compensated for by the fact that in such localities a better price can be obtained for light,—the converse also naturally being true to a degree.

It is possible that some of the figures given might be criticised from the point of view of the best theoretical engineering practice; here, however, is a condition and not a theory that confronts us, and in the stations now under consideration it would not be practicable to obtain such results as may be arrived at in large installations of possibly several thousand horse-power, fortified with the best expert design, supervision, and attention.

SAND FILTRATION OF DRINKING WATER,

FOR THE REMOVAL OF DISEASE-PRODUCING GERMS.

By George W. Fuller.

THAT danger lies in drinking water contaminated by the waste products of human life has been recognized for many years. The true significance of drinking polluted water, however, has been appreciated by sanitarians only during the past few years, and even now its relation to health is not understood by the general public. In earlier times, under the older theories of the causation of disease, which looked upon the improper mixing of the four internal humors as the basis of all disease, sanitary science found no place. Within the past thirty years, however, there has been established a new theory—the germ theory—of disease, which teaches that many infectious diseases are caused by specific organisms, known as "germs" or micro-organisms. As soon as it was known that the original source of infectious disease existed not *in* us but *around* us, sanitary science became a practical aid to humanity.

The important and rapidly-advancing science of bacteriology has taught us much in regard to the relation of bacteria to our own environment. It is true that bacteria exist in the air, soil, and water, on our persons, and, in fact, nearly everywhere; but it must be clearly understood that only a small percentage of the kinds of bacteria are harmful, just as it is true that only a few of the other and higher forms of vegetable life, such as trees and plants, are poisonous.

One of the most valuable lessons taught by bacteriology is that some disease-germs are able to live in ordinary drinking water for many days. The specific germs of typhoid fever and Asiatic cholera are among those which have been studied most thoroughly, and for this reason they will be used chiefly in the statistics and statements presented in this paper.

The results of numerous experiments by many investigators indicate that the typhoid bacillus is able to live in various drinking waters from three to eighty days. Repeated investigations at the experiment station of the Massachusetts State Board of Health, at

Lawrence, show that this micro-organism is able to live in the water of the Merrimac river at that point for at least three weeks. The duration of life of the cholera-germ in various drinking waters has been observed to be from two days to seven months.

Modern hygiene demands that a drinking water shall be free from disease-producing germs; and the means by which such water can be obtained are worthy of careful consideration. To obtain a water-supply in the great centers of population from the old-fashioned well is obviously inconvenient, and, moreover, it is unsafe. This fact is due to the contamination of the water by the waste products of human life, as is indicated by the death-rates from those diseases carried by water, in towns and villages drawing their drinking water from wells. In the introduction of public water-supplies the American people have not been slow. Up to this time more than $590,000,000 have been expended in public water-works, water being drawn from more than 2500 sources; but when it comes to the quality of the water the mortality statistics lead us to the belief that many American water-supplies convey the deadly germs of disease to the confiding consumer. Let us take for example the experience of Chicago. During the year ending September 30, 1892, there were in that city 1790 deaths from typhoid fever. The water during this period was at times seriously infected, and for this reason the tunnels were extended two miles farther from the shores of the lake. Owing largely to this step, in all probability, and to the use of boiled water or spring waters and filters, the number of deaths from this disease during the following year fell to 712, in spite of increasing population and the large number of visitors to the World's Fair. We are shocked when we learn of a railway accident in which a score of persons are killed and as many more seriously injured; but it is a significant fact that less attention is paid to the loss of thousands of lives yearly in this country due to infected drinking waters. Many of these deaths are apparently preventable and, until effective measures are adopted to afford relief, the exisiting conditions will continue to throw discredit on American science, American engineering, and American civilization.

In some localities satisfactory supplies of pure water can be had from driven wells and from surface water taken from watersheds which are free from human habitation. But it is very rare at the present time that great cities with their large suburban populations can obtain a sufficient quantity of perfectly safe drink-

ing water from either of these sources. It is possible, however, in some cases, to prevent at least to a large extent the entrance of unpurified sewage into a water-supply. The cities of Boston and New York, for example, have water-supplies taken from inhabited water-sheds which are carefully guarded. The table below shows the mortality rates from typhoid fever in Boston during the years 1846–1892. The Cochituate supply was introduced in Boston in 1848, and during the past ten years much has been accomplished towards keeping all sewage out of the water. This has been done in part during the past three years by the filtration of the sewage of Framingham and Marlborough, Massachusetts.

TABLE SHOWING DEATH RATES FROM TYPHOID FEVER IN BOSTON, 1846–1892.

Years.	Deaths per 10,000 Inhabitants.	Years.	Deaths per 10,000 Inhabitants.
1846–49	17.4	1870–74	7.6
1850–54	8.2	1875–79	4.2
1855–59	5.0	1880–84	4.9
1860–64	5.7	1885–89	4.1
1865–69	5.6	1890–92	3.2

While the quality of the Cochituate water at present is reasonably satisfactory, it may be stated in passing that the quantity from present sources will not be sufficient for an indefinite period, and investigations are already under way to provide for the increasing demands of Boston and the neighboring towns and cities.

Many water-supplies drawn from polluted sources have been introduced in America in recent years, apparently in the belief that the dangerous elements were removed from the water on its way to the consumers. It is true that a certain degree of bacterial purification is effected by dilution, by storage in a reservoir holding one or two weeks' supply, and by passage under pressure through miles of iron pipe. These agencies may be sufficient in some cases, but generally speaking these factors of safety are too small; and the experience of Lowell, Lawrence, Albany, Chicago, and numerous other places, involving the loss of hundreds of lives, shows conclusively that all of these conditions taken together may be insufficient to render an infected water safe at all times for drinking purposes.

At present many cities and towns,—and the number is continually increasing,—are obliged to face the problem, "How can the disease-producing germs be best removed from a polluted water?" From the results of long-continued investigations, together with

the experience of certain European cities, it is now believed that the requirements of modern sanitary science are satisfactorily fulfilled by properly-conducted sand filtration. This method of treating water was first introduced near London by James Simpson in 1839. It is the practice in Europe to pass the water through fields of thoroughly underdrained sand, of from three to five feet in depth. The surface of the sand is kept constantly covered with water. The sediment in the unfiltered water is deposited on and very near the surface of the sand. This gradually increases the resistance to the passage of the water through the sand until a point is reached when the quantity yielded by the filter is so small that it is necessary to scrape the filter,—that is, to remove the upper layers of clogged sand. During the past forty years many filter-plants have been constructed in Europe and numerous improvements have been made in the filtration of water. This has been the case particularly during the past decade, owing to the aid of bacteriology, which enables us to determine readily the efficiency of filtration with regard to the removal of bacteria. The operation of some of the filters is quite satisfactory, as is shown both by low death-rates from those diseases conveyed by drinking water and by the results of numerous bacteriological investigations.

The water from the river Thames, the source of a large part of the London water-supply, was examined bacterially for several years by Professor Percy Frankland before and after filtration. The average results for the years 1886, 1887, and 1888 showed a removal on the average of 97.6 per cent. of the bacteria present in the unfiltered water. The average death-rate from typhoid fever in London during these years was very low,—namely, 1.6 per 10,000 inhabitants.

The operation of the Berlin filters has also been watched closely, particularly at the works near the Stralauer Thor, which were under the direction of Piefke, the eminent engineer. Through the investigations of Piefke and of the bacteriologists of the Hygienic Institute at Berlin our knowledge of the removal of disease-producing germs from water by sand filtration has been much extended.

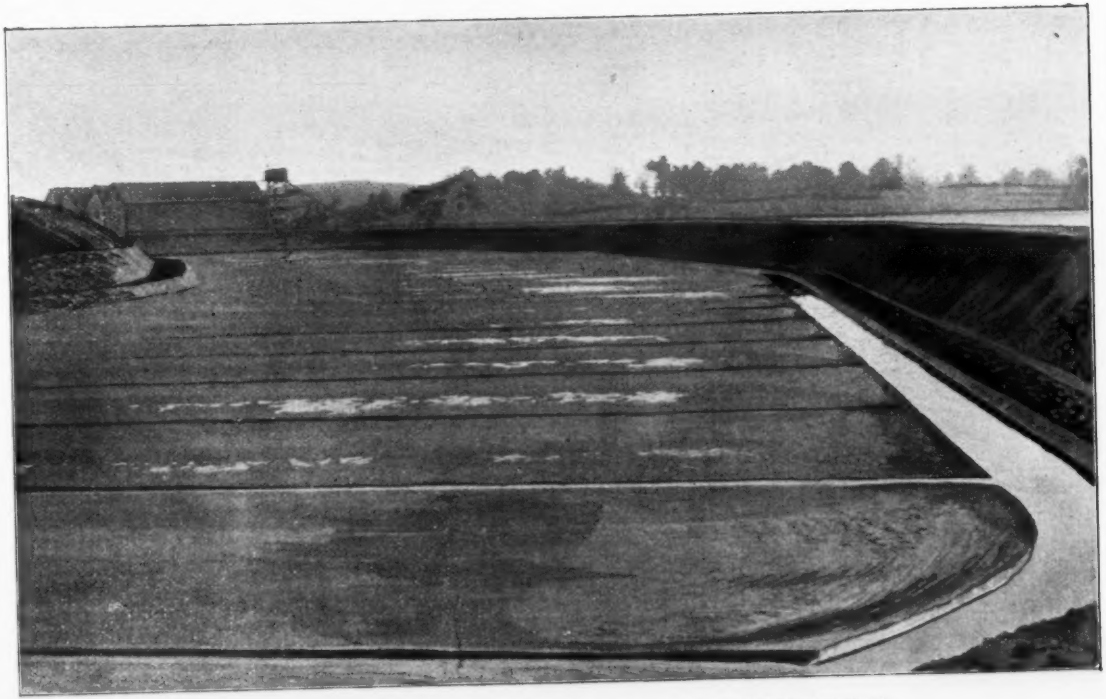
Massachusetts, earlier than most other American States, found difficulty in obtaining sufficient quantities of pure drinking water, particularly in the case of the larger cities in the eastern part of the State. The two largest rivers of the State are polluted with sewage before they enter from the border, and some of her own streams are also polluted. Under these circumstances the legisla-

LAWRENCE WATER-FILTER, SHOWING EMBANKMENTS.

ture determined to make an inquiry to learn how seriously the water-supplies were polluted, and also what could be done to protect and purify the water. This work was placed in the hands of the State Board of Health, which, since 1887, has systematically examined all of the water-supplies in the State. In 1887 the board established in Lawrence an experiment station, the object of which was to study the problems of the purification of sewage and water under the conditions existing in Massachusetts. The station was designed by Hiram F. Mills, A.M., C.E., who has directed the investigations. During the earlier history of the work attention was devoted chiefly to sewage-purification by intermittent filtration. The fact, however, that typhoid fever has been epidemic from time to time in Lowell, Lawrence, and other Massachusetts cities has more recently given an increased impetus to the study of water-filtration.

In the fall of 1887 a tank six feet deep and 1/200 of an acre in area was filled with mixed coarse and fine sand and a layer of loam six inches thick, the top of which was eight inches below the surface. The total depth of the filtering material was five feet. Water was applied sixteen hours a day to the filter, which was allowed to drain during the rest of the time and the pores of the sand fill with air. Such a filter is known technically as an intermittent filter, in distinction from continuous filters, the surfaces of which are covered constantly with water. The number of bacteria in the effluent was very low, usually below ten per cubic centimeter, and at times it was sterile. In 1891 elaborate preparations were made to determine whether any of the bacteria found in the effluent came down through the filtering material, or whether they had their origin in the underdrains, according to the theory of Bertschinger and other Europeans. The greatest care was taken to prevent contamination of the effluent by air and dust. The average results of 186 bacterial determinations indicated that from May to October, 1891, the applied water which had passed through the reservoir and service pipes of the Lawrence waterworks contained 175, and the filtered water 4.7, bacteria per cubic centimeter. This was a removal of 97.3 per cent. of the bacteria in the applied water.

To obtain more definite knowledge on the subject river water obtained direct from the canal was applied to the filter, beginning November 13, 1891. Several determinations were made daily of the bacteria in the water, before and after filtration, on the same nutritive medium, cultivated for the same length of time and at the



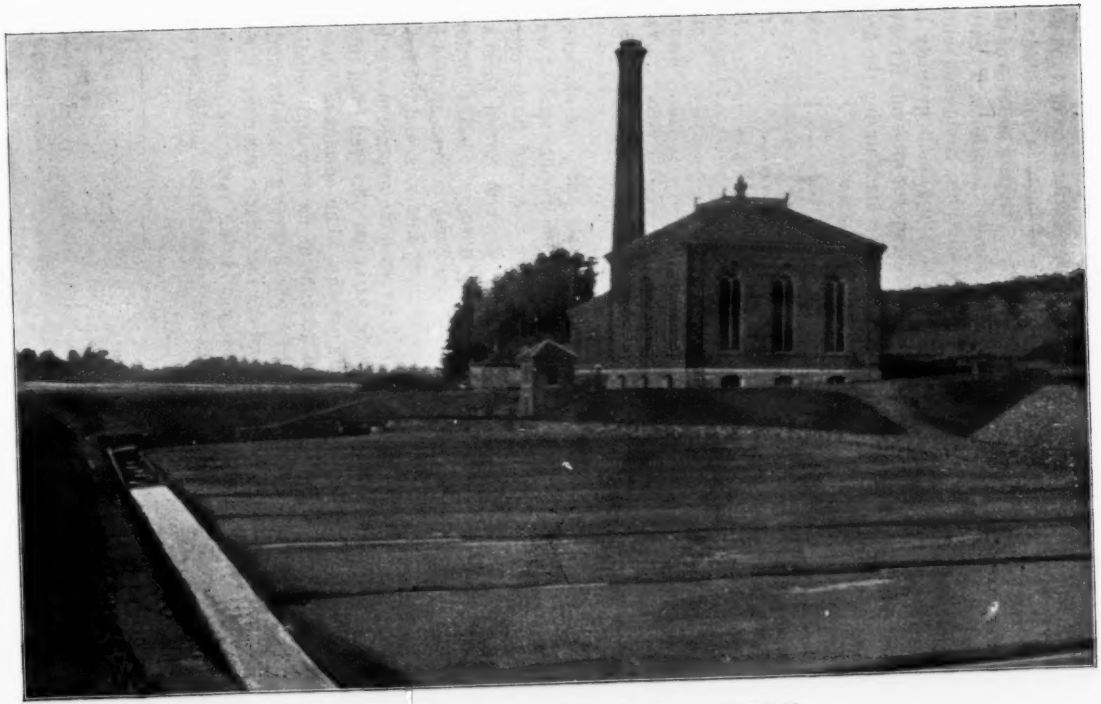
LAWRENCE WATER-FILTER, SHOWING SURFACE OF FILTER AND THE DISTRIBUTING CONDUITS.

same temperature. The average results from November 13 to December 31, 1891, of 102 bacterial determinations of the filtered water and 88 of the river water, showed that the river water contained 2660 bacteria per cubic centimeter, and the filtered water 0.83,—which was a removal of 99.97 per cent. No relation could be found between the number of bacteria in the effluent and that in the river water, or any influence from the rate at which the water flowed from the filter. Of the 102 determinations, 58 indicated that the filtered water was sterile.

Numerous quantitative determinations of the kinds of bacteria in the unfiltered and filtered water were made. One of the most striking results was that *B. coli communis*, the leading species of bacteria in human feces, and which during November and December, 1891, formed 39 per cent. of the bacteria in the water of the Merrimac river at Lawrence, was not found in the filtered water. Two other prominent kinds of bacteria in the river water were absent in the filtered water; moreover, the presence in the effluent of the very small number of bacteria was satisfactorily explained by their specific similarity to those bacteria found in the air, the outlet pipe, and the underdrain.

From this evidence it was concluded that with these filtering materials and under these conditions all the bacteria of the Merrimac-river water may be removed by filtration. This filter was continued in operation during the following year, and the degree of bacterial removal remained most satisfactory. The only objection to this filter is the small quantity of water which it will yield. The average rate of filtration has never exceeded 250,000 gallons daily, per acre, and the adoption by cities and towns of filtration through such materials would be very costly. A large amount of attention, therefore, has been devoted at Lawrence to the study of filtering materials coarse enough to filter a municipal supply economically, while removing the disease-producing germs.

Fourteen experimental water-filters were constructed during 1892. The construction and operation of these filters, as well as of the older ones, were such as to throw as much light as possible upon the laws of filtration. Since the removal of bacteria is one of the most important points in the filtration of water, the experiments were arranged so as to allow a direct comparison of the power of removal of bacteria from the water under different rates of filtration, with sands of different degrees of coarseness, with different depths of the same sand, with the presence of loam lay-



LAWRENCE WATER-FILTER, WITH PUMPING-STATION AND GATE-HOUSE.

ers, and with continuous and intermittent filtration. The actual efficiency of the filters was tested by the application of typhoid-fever germs and other important kinds of bacteria, and observations on their passage through the filters. The pure cultures of the micro-organisms were grown in dilute bouillon solutions. Twenty-five or fifty cubic centimeters of these solutions, containing millions of germs, were applied to the filters in a small quantity of water, and the effluent was examined at frequent intervals for several days. Fifty-five such experiments were made during the first five months of 1892, with these average results:

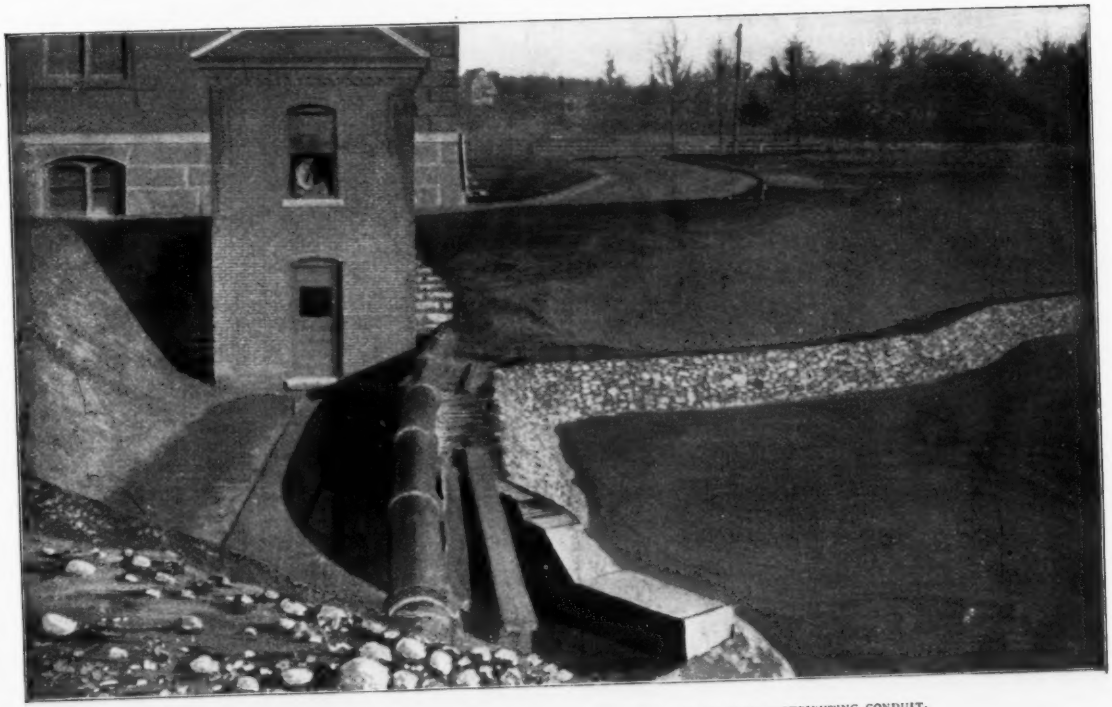
Number of filters tested	11
Number of experiments with typhoid-fever germs	22
Number of experiments with *B. prodigiosus*	19
Number of experiments with *B. coli communis*	14
Average rate of filtration, gallons per acre, daily	1,350,000
Number of bacterial determinations	914
Average number of bacteria per cubic centimeter applied	104,200
Per cent. removed	99 48

[The extreme limits in the rates of filtration in the several experiments were 280,000 and 2,600,000 gallons per acre, daily.]

These experiments were very severe tests upon the efficiency of the filters in removing bacteria, because the number applied was probably greater than would occur in practice, and furthermore the organic matter introduced with the bacteria served them as a food material. The experiments made during the latter portion of the year are much fairer, because the bacteria were applied in small and long-continued doses at frequent intervals, and the food material applied with them did not increase the organic matter in the river water beyond the limits of variation observed from time to time in the amount originally present. The species of bacterium used was *B. prodigiosus*, on account of its easy and reliable differentiation, its similarity to the typhoid-fever germ in its mode of life in Merrimac-river water, and the fact that it has never been found native in this country. In the following table are summarized the average results of daily experiments from September 16 to December 31, 1892:

Number of filters experimented upon	11
Number of bacterial determinations	2,372
Rate of filtration, gallons per acre, daily	1,700,000
Average number of *B. prodigiosus* per cubic centimeter applied	5,700
Per cent. removed	99 87

Daily determinations were made of the ordinary water bacteria



LAWRENCE WATER-FILTER, SHOWING GATE-HOUSE AND UPPER END OF MAIN DISTRIBUTING CONDUIT.

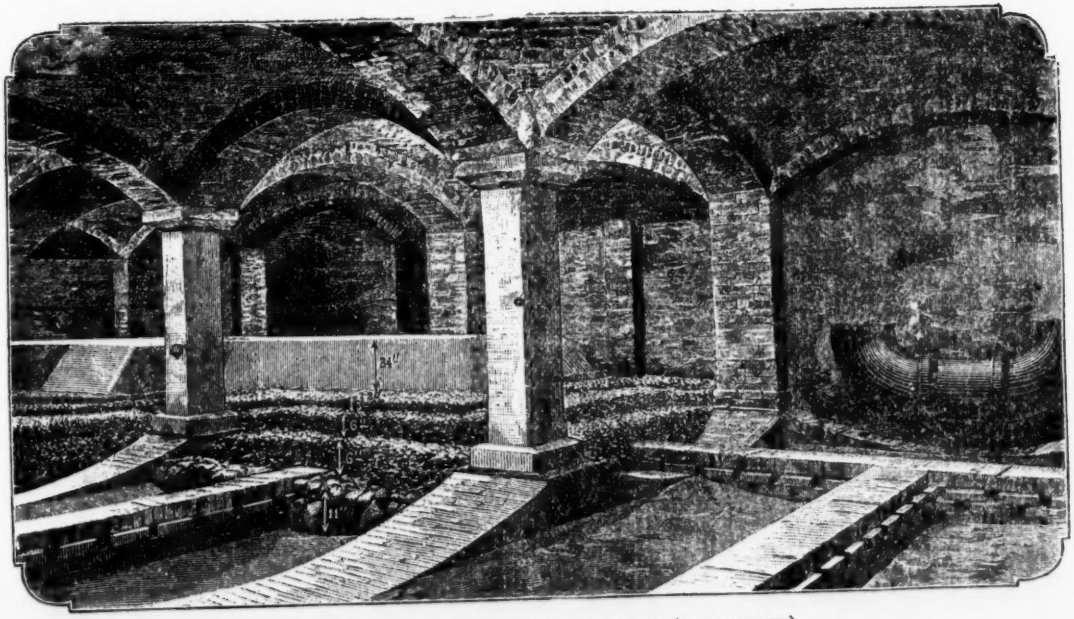
present in the unfiltered and filtered water. It was found that the true degree of bacterial removal was apparently obscured, to a certain extent, by the presence in the water of small numbers of very hardy bacteria which do not appear to come down through the filtering material with the applied water, but seem to have their origin in the underdrains, where they continue to live on the very small amount of food present. The average results of the bacterial determinations of more than 5000 representative samples of unfiltered water and filtered water indicated that the river water contained 8780 bacteria per cubic centimeter, of which 99.21 per cent. were removed by filtration.

As has been stated already, the sediment in the unfiltered water is deposited on and very near the surface of the sand. In time the surface sand becomes so clogged that it is necessary to scrape off $\frac{1}{8}$ to $\frac{1}{4}$ inch. In Berlin it is believed that the efficiency of the filter depends on the scum which is formed at the surface, and in some places in Europe it has been found that the effluent contains as many bacteria just after scraping as the unfiltered water. The efficiency of the experimental filter at Lawrence, under the existing conditions of operation, varies very slightly during the period between scrapings. The average results of 42 scrapings, at times when the conditions of filtration were practically the same before and after the operation, indicated that during the three days before scraping 99.68 per cent. of the water bacteria were removed and 99.45 per cent. during the three days after scraping; with *B. prodigiosus* these figures became 99.96 and 99.89 per cent., respectively. With filters of coarser sand and higher rates of filtration the effect of scraping probably would become more marked.

It should be stated, however, that it is the upper portion of the filter which largely accomplishes the bacterial purification. This is brought out most clearly by the table below, which shows the number of bacteria per gram found in the sand of a continuous filter which had been in operation from May 2 to October 26, 1892. This filter, nine inches deep, was scraped on October 15 and was again clogged on October 26, the date of examination:

Depth from Surface.	Bacteria per Gram.	Depth from Surface.	Bacteria per Gram.
0—¼ inch.	1,100,000	2 inches.	21,000
½ inch.	320,000	4 inches.	4,000
1 inch.	140,000	6 inches.	1,600

During the past year the city of Lawrence has constructed a



A COVERED FILTER, WATERWORKS OF WARSAW, RUSSIA (AFTER LINDLEY.)

large water-filter which was put in operation September 20. This filter, which was designed by Mr. Hiram F. Mills, is about 2½ acres in area and has a calculated daily capacity of 5,000,000 gallons. The filter is separated from the river by a high embankment made from the material excavated from the site of the filter. The excavation was carried to a depth of seven feet below low water in the river. The filtering sand placed in the excavation was selected with the greatest care ; the general level of the surface of the sand is 2½ feet below low water in the river. The filter is flooded by the water passing through a two-foot gate to an open cement conduit, running the entire length of the filter, at the foot of the embankment ; thence it overflows into shallow distributing conduits which cross nearly the whole width of the filter once in thirty feet.

The bottom of the excavation has cross ridges directly beneath the distributing conduits, and two feet higher than the depressions between. In the depressions, half-way between the tops of the ridges, are open-jointed pipes surrounded with gravel and stones. These pipes extend part way across the bed, once in thirty feet, and conduct the filtered water to a conduit which extends along the land side of the filter and thence to the pump-well. The sand above the ridges is three feet deep and is coarser than the sand above the collecting-pipe, where the depth is five feet. The object of this is to render a uniform flow of water through the filter. When the filter is in operation the water stands about 1½ feet deep over the surface of the sand. The cost of this filter was about $60,000. The chief running expense is the scraping, which means the removal of ⅛ to ¼ inch of clogged sand about once a month on an average. It is necessary to replace the material removed. The operation of this filter,—the first and as yet the only one of its kind in America,—differs from those in Europe chiefly in that it is operated intermittently and the pores of the sand are allowed to fill with air each day. This facilitates oxidation processes and appears to have an advantage over continuous filters, because it removes more of the organic matter which accumulates at the surface of the sand. With regard to the efficiency of this large filter, it may be stated that it removes 98 per cent. of all of the bacteria in the river water and, in addition, it removes a large part of the organic matter by converting it to harmless mineral matter. The removal of this organic matter, the food upon which the bacteria live, aids in causing the 2 per cent. of the bacteria remaining in the filtered water to decrease upon the passage through the reservoir and

service-pipes, so that the water as it reaches the consumers contains but one-half of 1 per cent. of the number of bacteria in the river water,—that is, a total removal of 99.5 per cent. The small number of bacteria remaining in the water, moreover, are of a few hardy kinds which are not known to be in any way injurious to health, and leave the strong probability that all disease-producing germs have been removed. It is also gratifying to note that there has been already a marked decrease of typhoid-fever mortality in the city.

The evidence so far presented on the efficiency of filtration is largely of a laboratory nature. Let us now turn to some of the largest cities of the world and compare the number of deaths from typhoid fever, for five years, with the character of the water-supplies in each instance, since drinking water is one of the chief carriers of the germs of this disease. Of the cities mentioned in the table below, Boston and New York have water-supplies taken from inhabited water-sheds, which are so carefully watched that only a relatively small amount of sewage enters either of the supplies. Philadelphia, Chicago, London, and Berlin draw large portions of their drinking water from sources known to be polluted. London and Berlin carefully filter their supplies through sand, while Philadelphia and Chicago do not. Vienna and Glasgow draw their supplies from distant and uncontaminated mountain lakes.

AVERAGE DEATH-RATES AND PERCENTAGES OF TOTAL DEATHS FROM TYPHOID FEVER IN EIGHT LARGE CITIES.

[For the Years 1887–1891, Inclusive.]

City.	Average number of Inhabitants.	Average Number of Total Deaths.	Average Number of Deaths from Typhoid Fever.	Death-Rate from Typhoid Fever per 10,000 inhabt's	Percentage of Typh'd Fever deaths to total deaths.
Boston.....	428,580	10,256	170	3.95	1.66
New York .	1,584,546	40,510	384	2.48	0.95
Philadelphia..	1,033,406	21,545	698	6.77	3.24
Chicago.. ...	1,029,200	19,550	843	8 26	4.31
London.....	4,139,400	83,440	602	1.46	0.72
Berlin (a)....	1,519,400	31,872	196	1.30	0.61
Vienna	806,207	20,332	92	1.15	0.45
Glasgow....	565,710	12.770	100	1.78	0.78

(a) Four years—1887-1890 inclusive.

Knowing the condition of the water-supplies of these cities, this table is very instructive in that it indicates that a great safeguard against typhoid fever is afforded, in the cases of London and Berlin, by filtration. It shows furthermore a point which should not be forgotten, namely, that pure drinking water does not necessar-

ily mean absolute freedom from typhoid fever, because the specific germ may enter the system in milk or other foods and in other ways, as well as by drinking water.

A still more striking illustration of the efficiency of filtration is given by the experience of Hamburg, Altona, and Wandsbeck, with cholera, in 1892. Of these neighboring cities Hamburg and Altona are on the river Elbe. Each draws its water-supply from the river; Hamburg with its intake above the city supplied its citizens with unpurified water; while Altona took its water from the river at a point below the outflow of both the Hamburg and Altona sewers, but filtered its water carefully before using. Wandsbeck secured its water supply from an inland lake and also used sand filtration. Reincke gives the cases and deaths from cholera in these cities, in 1892, as follows:

City.	Population.	Cholera cases per 10,000 Inhabitants.	Cholera deaths per 10,000 Inhabitants.
Hamburg.....	622 530	290	122.8
Altona.....	143,000	40	23 4
Wandsbeck.... ..	20,000	32	21.5

German sanitarians also claim with reason that many and perhaps most of the cases in the latter places were directly imported from Hamburg, and were not due to local causes.

ELECTRICITY IN SUBURBAN DEVELOPMENT.

By Erastus Wiman.

TO those who lift themselves away from political prejudice, and endeavor to comprehend the economic situation in the United States from a purely impartial point of view, there does not seem to be an early prospect for a period of great prosperity or activity. Looking deep down into causes of the present depression, it is evident that there are conditions which are universal and which no legislation will soon remedy,—which no policy will change for a good while to come. An economic revolution extending over a decade, or even longer, may be necessary to restore an equilibrium to the machinery of business, or an activity to enterprise equal to that which has prevailed in the past ten years. Perhaps a war in Europe, pushing up prices of produce to remunerative rates, would restore prosperity to that vast substratum of population, the agricultural class, on whose prosperity all else depends. This class, comprising more than half the population, and those immediately dependent upon it, comprising one-third of the remainder, cannot be legislated into prosperity. Their power to buy and pay rests on prices made abroad, and until, by war or by some great change not now apparently probable, a profit is possible for this wide area of purchasers, all the "politics" in the world will not improve the economic conditions that now prevail.

Under such circumstances it would seem the part of wisdom to attempt a readjustment of affairs to meet the conditions that are likely to prevail. An inventive skill might well find play in the efforts to get around the hard times by plans and modes which in good times might never have been dreamed of. Necessity, that mother which in the past has nourished so many inventions, may now be more fecund than ever, and thus progress, employment, and profit may be possible, where otherwise it would seem difficult to wrest them from the adverse circumstances of the period.

There are two classes in very many localities in the United States now seriously affected by the hard times who could, by a union of interests, materially help each other and promote the general prosperity. Either class, operating upon its own account, is

likely to have a slow time of it; but united both might make substantial, if not rapid, progress. These two classes are the owners of suburban property and the owners of electrical plants. The owners of suburban properties need of all things something to make their holdings accessible, that the demand for homes may be readily met, and their property easily marketed. This can be best done by the second class referred to, namely, the owners of plants now used chiefly at night for lighting purposes, but which might be employed during the day for producing and transmitting energy that would be available for traction on streets at a minimum of cost for construction and operation.

In every town of considerable size in this country there will be found a necessity for expansion; for, notwithstanding the hard times, babies will be born, young people will marry, and increase of population will go forward. But the great problem to owners of suburban property is how it is to be rendered accessible, and how in these times capital can be induced to build railroads and improve the communication sufficiently to bring property into market. A paralysis has practically set in upon new enterprises which look forward for a reward in the shape of a growth of traffic years hence, and there is little or no prospect for development except at the cost of the landowner himself. He is generally so land-rich and money-poor that this possibility is remote, and the prospect of growth and readiness for the expanding population seem distant.

In the same town, however, like enough, there is an electric-lighting plant that is making only a partial success. True, things have improved a good deal in the last few years, and, after sinking a small fortune in experimenting, there is now a margin of profit perceptible between receipts and expenditure. But with the hard times there is no possible expansion in the business, and with a constant depreciation in this class of property there is no prospect of increased profit without a growth of the town that now seems impossible unless some new effort is made.

These two classes of property-owners do not seem to have much in common,—this suburban burden-carrier on the one hand, and this sanguine but somewhat disappointed and subdued electric-light promoter on the other. Yet each possesses the element that the other needs to develop his interests, and united they can help each other to success and profit.

Hitherto the suburban property-owner has taken all the profit of suburban development by electric roads. While capitalists and

electrical promoters have put up the money, borne the risk, and done the work, the owners of land along the line have raked in the "shekels." But this is now no longer possible. The electric promoter has about reached the limit of the capital he can for this purpose control. The banker and the investor are becoming timid regarding new enterprises, and without a very large margin of promise new enterprises, in the shape of suburban expansion particularly, are just now unlikely.

But with a union between all the parties concerned, the advantages of a broad basis for capital are afforded. A united effort, under vigorous and combined management, is possible, and such a division of profit probable that the enterprise would attract attention and invite capital. Thus the large gains which are possible to suburban development, by the transposition from land in acreage to land in lots, would be rendered much more rapid of realization if merged into a deal in which the electric interest participated, or if by a union between them capital was attracted which could now be drawn to neither alone.

Union between the landowner and the electric-light company therefore seems desirable. As the latter is already an organization capable of expansion and of divisibility, it would seem that its powers might be made available. By enlarging or reconstructing it the company could be made an instrumentality large enough to include (1) the light company; (2) the land; and (3) the electric road. The new combination might with propriety be rechristened, —in order to cover and explain its purpose,—as "The Electric, Land, and Railway Company." Into this company could be merged all the interests to be served, and in its bonds, preferred and common stock (as hereafter to be explained) sufficient profit, safety, and attraction might be found for capital, not only locally but from abroad.

It will be asked, What is the prospect for money for these purposes in these hard times? It may be answered that the prospect for money for development of the property and the expansion of electrical enterprises is much more probable by a union of these two interests than by keeping them separate. Both have elements of profit exceedingly potential if united; neither now has any attraction for money, if separated. There is plenty of money,—never was it such a drug as now. For weeks call-money in New York has been at 1 per cent. per annum. There is just as much money in the country as ever there was. It has not been lost in

the woods, it is not buried in the earth, nor has it been shipped abroad in ocean greyhounds. This money has got to earn an honest living for the people who own it, just as the electric plant has got to earn a living for its promoter, or the suburban property for its owner. The need of the hour is to bring the three elements together, and that can better be done by a union of the two latter than by any other plan known to those who give most attention to the course of investments, and the projects wherein the greatest elements of profit reside in combination with safety.

It is beyond contradiction that, taking a survey of all classes of investments in the past ten years, no single department of industrial effort has yielded an enhancement of values so great, so universal, and so secure as the profits made by suburban development, aided by electric roads. Starting at Boston, the most conservative of centers, and long ago thought to be practically a completed city, the increase of values created by the expansion of Mr. Henry M. Whitney's West-End street-railway system has been greater than the gain in any other interest. Bank stocks, insurance stocks, railroad bonds, industrial securities, and the thousand other instrumentalities which provide great numbers of Bostonese with bread and butter have barely held their own in the best cases, while in very numerous instances they have declined in values, and some have ceased to yield the harvest even of hope. But the West-End system has not only steadily earned a large return, but steadily enhanced in earning power, while the thrill of life in property along its lines, far out of town, has imparted a new vitality and an enhanced value.

So it is all over the country. In great cities like Rochester, Buffalo, Cleveland, Cincinnati, Chicago, Milwaukee, Atlanta, Omaha, Kansas City, and numerous smaller places the gain in value, the growth in population, the enlargement of area, the stimulation of building, and the general vitality resulting from electric-railway extension is more pronounced, is more secure, and is founded on a better basis than has been created by any other form of investment.

There may have been some exceptions to this general conclusion, and undue expansion ahead of the demand may have resulted in a few instances in loss and delay in return. It would not be surprising if this were so, for, as with other good things in this world, the maxim applies, "The greater the good, the nearer the evil." It may be safely claimed that in proportion to the ground

covered, the amount of money spent, the number of undertakings pushed forward, and the social, material, and financial results achieved, no class of investment has been so profitable, and so eminently satisfactory, as electrical-railway suburban development.

With this general conclusion admitted, there ought to be no serious difficulty in numerous minor localities to perpetuate this impression, and steadily realize a similar result. This can best be done in the way herein suggested for smaller places, namely, by a union of an existing organization in the shape of a local electric-light plant and suburban property, the two uniting their advantages to invite the third—local capital—to complete the necessary means of communication, and render readily accessible the property now dormant and dead in realizable value. The property-owner must make up his mind to share with others the enhanced value, as something to which their investment, organization, and experience entitle them. He will make twice as much money in five years by this union as could be made in ten years by isolated and restricted opportunity for realization.

The electric company will also be benefited by an enlarged chance from development, the employment of much that is now idle all the hours of day, and by putting into constant use the forces of organization, expert knowledge, experience, and the manifold advantages which exist in a going concern.

The investor, too, either local or from abroad, will find a ready opportunity for the employment of capital right under the sphere of his own observation. Instead of buying bonds on railroads a thousand miles away, subject to all the chances of competition, crop failures, traffic reduction, and mismanagement, there will be in such local enterprises as are here suggested an opportunity for observation, direction, management, and general interest impossible in far-away undertakings.

It may be asked what one thing more than others would encourage a movement of this character, and give shape and form to this suggestion of a union between electrical plants and suburban development, the two thus united inviting capital. The reply is that legislation has already set in motion the incipient stage of this movement. By a new general law of the State of New York electric-light companies, outside of cities of large class, by a very slight formality may become possessed of all the powers of a railroad company, under which a construction could be carried forward

to any point, or in any direction, that public policy permitted. The smallest electric-lighting company in the State can thus be possessed of all the powers enjoyed by the New York Central and Hudson River Railroad Company. With these privileges and powers in hand there are hundreds of towns in which electric-light plants now lying idle all day long could be made available with slight added expense. Even if their capacity had to be doubled they could be made available at far less expenditure than new undertakings, which nowadays are hardly to be thought of.

The New York law as it exists, while it imparts to electric-light and -power companies the privilege of railroad construction and operation, does not contemplate the acquirement of land and its improvement, sale, or lease. This amendment it is proposed now to seek, so that three purposes can be accomplished at one and the same time, namely, (1) the creation of light and power; (2) the construction and operation of an electrical railroad; and (3) the acquirement and development of suburban property.

In order that the full scope of the measure may be understood, and that the residents of other States may be informed of what is done and is proposed in New York, the full text of the bill is herewith printed. Being an amendment of a previous act the new bill is somewhat clumsy, but its general purport will be understood:

AN ACT to amend the railroad law, in relation to electric-light and -power corporations becoming railroad corporations.

When all the stockholders of any domestic electric-light and -power company, incorporated under a general law of the State of New York, having not less than five stockholders, and actually carrying on business in this State, shall execute and file in the offices in which its original certificates of incorporation are filed, an amended certificate of incorporation, complying in every other respect than as to the number of signers and directors, who shall be not less than five, with the provisions of the railroad law, and in which certificate the corporate name of such corporation shall be amended by adding before the word "company," in its corporate name, the words "and railroad," or the words "railroad and land"; such corporation shall have the right to build, maintain, and operate, by electricity as a motive power, a railroad not exceeding twenty miles in length, and such corporation shall otherwise be subject to all the provisions of this chapter, *and have all the powers, rights, and privileges conferred by it upon railroad corporations*, provided that no such corporation shall construct any railroad, which is in whole or in part a street-surface railroad, without complying with the provisions of Article IV of this chapter. Upon filing such certificate such corporation shall also have the right to acquire by gift or voluntary purchase and sale, lands not exceeding two thousand acres, and to hold, improve, lease, and sell the same. This section shall not apply to any railroad now located in whole or in part, or hereafter to be so located, in any city whose population at the last census was 50,000 or more.

Inasmuch as legislatures are now in session in a number of States, it might be desirable for parties in interest to have this law early introduced, and its passage secured for future use. Beyond all doubt its existence will be an incentive to considerable effort in the direction herein suggested. There are literally thousands of towns in different States in which a similar law could be made available for the highest degree of usefulness, development, and increase in value. The existence of such a law makes possible a union of interests now separated and restricted, which, if united, would do more to stimulate activity in expenditure by construction of roads, opening up property, building homes, and generally enhancing values than almost any other piece of legislation now possible.

Enough has been said to set forth the general idea of a possible union between divergent interests for the advantage of many minor localities and individuals. If it is desirable to further discuss it, or if the readers of the Magazine should manifest an interest in the subject, some suggestions of a practical nature could be made as to modes of adjustment between these interests, and plans discussed, as to how the capital can be had, and details as to classes of securities to be created. These would be the result of a good deal of thought and experience in relation to companies now being promoted.

THE FASTEST CRUISER IN THE WORLD.

By Walter M. McFarland, U. S. N.

GREATER interest has been felt in the triple-screw cruiser *Columbia*, from her inception to her recent remarkably successful trial, than in any other of the new ships of the United States navy. Two causes have contributed to this: she was designed to be the fastest cruiser in the world, and a radical change in the disposition of the propelling apparatus was adopted. It has long been the policy of the Navy Department to rely upon fast cruisers, to act as commerce destroyers, for the greater part of our fleet, and the way had been gradually prepared for a vessel like the *Columbia*, which should combine very high speed with great coal endurance, thus putting her more nearly on a par with the "greyhounds" of the merchant service, many of which have bunkers that are veritable coal-mines.

A careful observer of the performances of fast steamships need not be technically educated to notice that high speed and large dimensions go together in vessels intended for anything more than a spurt. The reason for this connection is that the cost of driving the large vessel is less *per ton* than for the smaller ones.

After careful consideration it was decided that the *Columbia*,—then known officially as *Cruiser No. 12* and popularly as "the Pirate,"—should be of about 7400 tons *normal* displacement, 21 knots sustained sea speed, 22 knots maximum speed in smooth water, and about 20,000 horse-power. It may be explained that the term *normal* displacement means what will be about the average displacement in ordinary cruising. With the coal-bunkers completely filled and all stores on board, the *Columbia* will displace about 8650 tons.

With the size and general dimensions of the vessel settled, the problem of the naval architect did not differ greatly from that for any other vessel of about the same size, but the problem for the marine engineer was one requiring special care because of the unusual amount of engine power and the peculiar limitations for the designer of naval machinery.

It has been stated that an increase of size is attended by economy of propulsion *per ton*, but there is an actual increase in the total power required to drive the large vessel, so that it would

obviously be a mistake to increase the size beyond actual requirements. In fast merchant steamers the problem is comparatively simple. The vessel is to be driven always at a certain speed and the machinery must be capable of securing this speed with economy and durability. Long experience has shown that to secure these essential features there should be comparatively slow-running engines whose cylinder ratios provide for considerable expansion, and boilers with ample heating- and grate-surface, so that there need be little forcing, while ample weight and space must be allowed.

Naval machinery, on the contrary, has to fulfil two very different conditions. It must be amply powerful to secure the desired maximum speed for comparatively short periods—twelve to twenty hours—and it should work with fair economy at ordinary cruising speeds, which nowadays are about half the maximum, corresponding to about an eighth or a tenth of the maximum power. As has been very cleverly stated by Professor Hollis, of Harvard University, the problem is like that of constructing a man who shall have the appetite of an infant ordinarily, but the stomach capacity of a giant for special occasions. The comparatively small size of naval vessels will not permit either the space or the weight of the merchantman for maximum power, so that recourse is had to forced draft for the boilers, high speeds for the engines, and careful selection of materials with reduced factors of safety. This gives smaller engines and boilers, but they are not so economical.

Notwithstanding this reduction of size, the machinery is still enormously too large for economy at low speeds. The undue friction of moving an engine ten times too large will at once be evident, and there are other causes, a discussion of which would be too technical for this article, of greater moment in reducing economy. It is evident, therefore, that some provision must be made for subdividing the engines so that, at low speeds, a portion of them may be thrown out of service, leaving a smaller engine of a size appropriate to the work. Various methods have been adopted to secure this object. In the *New York* there are two engines on each of the twin shafts, and the forward ones can be disconnected, leaving the after ones to do the work at low powers. This plan, however, requires the shafting abaft the after engine to be of the same size as for a single large engine, and it has the disadvantage of doubling the number of parts of the engines and requiring about twice the space and number of attendants necessary when there is only a single engine on the shaft.

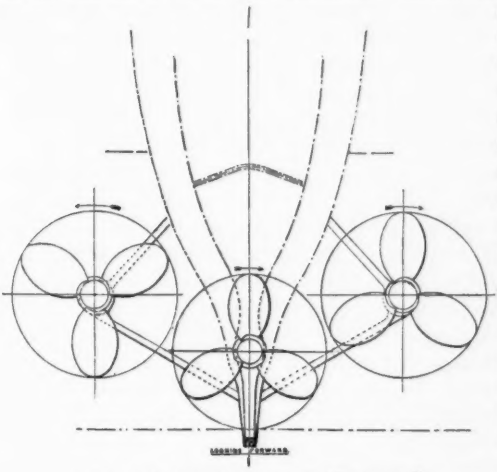
Careful study of all the conditions led Engineer-in chief Melville to decide upon the use of triple screws. This plan has the advantage of providing very nicely for a size of engines appropriate to the power desired at several aliquot parts of the total power; it has only one-half more parts than twin screws with a single engine on each shaft; it occupies less room than the plan adopted for the *New York*; the chances against a total breakdown are increased from two to three, while in the *New York* they are no greater than for an ordinary twin-screw ship; the size of the engine for each shaft is less than for a single engine on each of twin shafts; and there is good reason for believing that the economy of propulsion is greater than with twin screws.

The two features which had greatest weight in deciding the adoption of triple screws were the greater economy of using a single engine at low powers, and the reduction in size of parts as compared with twin-screw engines. When a single engine is used the other two shafts are disconnected as far aft as possible and the idle propellers allowed to revolve freely. It requires the expenditure of some power to drag these screws through the water, but this is much less than might be supposed by those who have not investigated the subject, and is much more than offset by the increased economy of one engine of moderate size as compared with two large ones. Twin screws would have required each shaft to transmit about 10,000 horse-power, and, although this is exceeded in some of the large merchant steamers, it is believed to be better practice to keep within this limit. In any case, the smaller shafts are undeniably safer, as the difficulty of assuring the integrity of large forgings increases more rapidly than the size.

The credit of this design is due entirely to Engineer-in-chief Melville. It is the common practice to give the head of an office credit for all that is done, but in this case he not only assumed the responsibility but settled the design, without any suggestions from others except of an adverse nature. Many eminent engineers deprecated the plan as wholly experimental and unwise for the crack ship of the navy. But the plan was not experimental and Melville's credit is deserved for his courage in applying on the largest scale what had already proved a success on a smaller one.

The use of multiple screws is by no means new, dating back to the civil war, where they were used on light-draught boats on the Mississippi called "tin-clads," but the object was merely to se-

cure adequate area of the propeller. They were also used on the Russian circular ironclads called "popoffkas" and the Russian imperial yacht *Livadia*, but as these vessels were failures they cannot be considered precedents. In 1884 the *Tripoli*, of the Italian navy, was laid down, and in her the arrangement of the screws is about the same as in the *Columbia*. About the same time an elaborate series of experiments was carried out in France on a steam-launch fitted with triple screws, and an account of these was published in 1886. The *Tripoli* was tried in 1887 and proved entirely successful. The Italians have also built the *Montebello* and the *Monzambano*, sisters of the *Tripoli*. All of these vessels are small torpedo-gunboats of about 800 tons and 3000 horse-power.



POSITION OF SCREWS IN THE U. S. S. "COLUMBIA."

The *Dupuy de Lôme*, of the French navy, was projected in 1887 and began her trials last year, but owing to accidents to the boilers they have not yet been completed. Her displacement is about 6200 tons and her horse-power 14,000,—only two-thirds as great as the *Columbia's*. When the use of triple screws for the latter was decided upon it was not definitely known that they would be used on the former; they had been included in the original design, but statements had appeared that they had been abandoned for twin screws. The French have two battle-ships building which will use triple screws, but their horse-power is only 11,000. The Germans have one triple-screw vessel, the *Kaiserin Augusta*, which participated in the naval review at New York last year. Her displacement is about 6000 tons and her horse-power about 12,000. When the *Columbia* was designed it was not known that this vessel

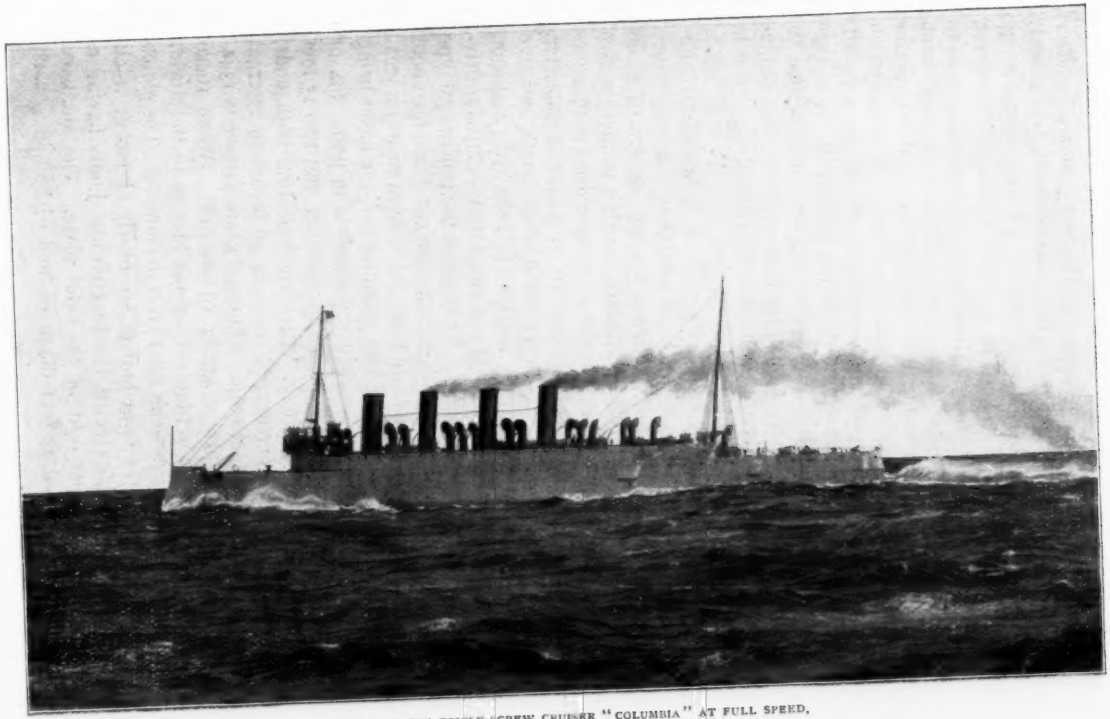
was projected. The arrangement of her screws is different from that of the *Columbia*. It is thus apparent that the *Columbia* is the largest vessel thus far tried with triple screws, while her power is very much greater than that of any other vessel using this system of propulsion.

The *Columbia* is a protected cruiser, which means practically that she has no side-armor, the protection of magazines and machinery being by an armor-deck. This consists of inclined portions at the sides, running from about 4½ feet below the water-line at the sides to about a foot above where they join the horizontal central portion. The inclination is about 30 degrees. The inclined sides are four inches thick and the central part about 2½ inches.

As in all large war-vessels, the under-water portion of the hull is double and minutely subdivided into water-tight compartments. As long as the inner bottom is intact, the outer bottom can withstand a great deal of damage. In fact, everything possible in a vessel of this kind has been done to guard against damage by torpedoes. There is also a central longitudinal bulkhead throughout the machinery space forward of the central engine, and the coal-bunker bulkheads alongside the boilers are water-tight. Numerous athwartship water-tight bulkheads are also fitted, so that, besides the cellular subdivision of the double bottom, the whole interior of the ship partakes of that character.

The battery consists of four 6-inch breech-loading rifles, eight 4-inch rapid-firing breech-loaders, eighteen machine-guns, and six torpedo-tubes. Where the 4-inch and machine guns are placed the ship's side will be armored with 4-inch and 2-inch plates, respectively. The 6-inch guns will be protected by heavy shields attached to the carriages.

For the preservation of the stability by keeping the water-line intact there is a coffer-dam or compartment next to the skin on each side above the protective deck, five feet in width and about seven feet deep, extending the length of the ship. This will be packed with cellulose, which is a water-excluding material. When a shot passes through this it closes and reduces the ingress of water to an inappreciable amount. As the function of the *Columbia* is to act as a commerce-destroyer she has been so designed as to bear some resemblance to a merchant vessel, thus enabling her to get within range before her true character is discovered. She is about 412 feet long, 58 feet beam, 22.5 feet mean draught, and has a displacement of about 7400 tons at that draught.

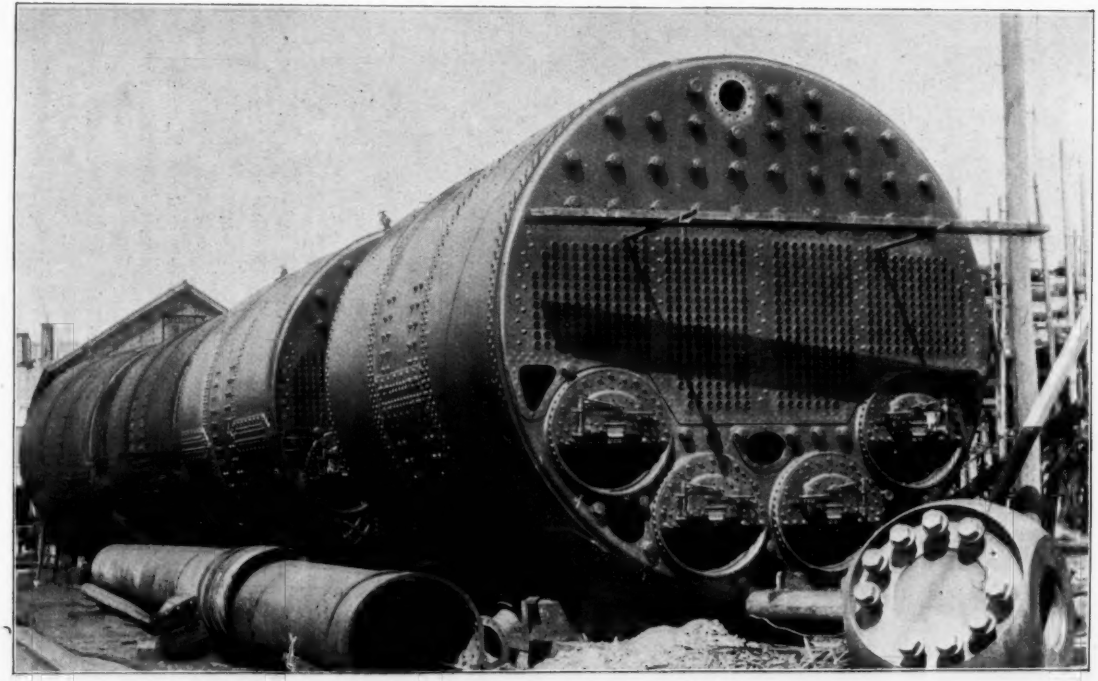


UNITED STATES TRIPLE-SCREW CRUISER "COLUMBIA" AT FULL SPEED.
[Making the World's Record of 22.8 Knots for Four Hours.]

The engines resemble those of fast passenger steamers in being vertical, but have a shorter stroke and run much faster. They are of the now common triple-expansion type. As already explained, each engine, consisting of three cylinders, drives a separate screw. The cylinders are 42, 59, and 92 inches in diameter, each having a 42-inch stroke. The engines are arranged so as to bring the starting gears as near together as possible, although each engine is in a separate water-tight compartment, and this places the high-pressure cylinders of the two forward engines, which drive the side propellers, aft, and that of the after engine forward. The main engines do nothing but drive the screws, all the pumps being independent and driven by special engines. In addition to contributing to smoother working of the main engines, this arrangement has such special advantages in their rapid handling that it is now universal for war-vessels.

Each engine has its own condenser, which is of brass, and cylindrical so as to reduce weight. Each condenser has nearly 4900 brass tubes about 12 feet long, giving a cooling surface of about 9500 square feet. The air-pump attached to each condenser is a fair-sized double engine itself, having two steam-cylinders 16 inches in diameter and two water- or air-cylinders 31 inches in diameter, with a 21-inch stroke. These pumps are almost automatic and give great satisfaction by their steady working and the little attention they require. Each condenser has two circulating-pumps for driving cold water through the tubes. They are of the centrifugal type driven by a single-cylinder engine, and the two can discharge about 14,000 gallons of water per minute from the bilge in case of a leak.

There are eight large and two small boilers, the latter being intended for use as auxiliaries when the vessel is in port. Six of the large boilers are 15 feet 9 inches in diameter and two 15 feet 3 inches, all being 18 feet long. They are fired from both ends, each end having four corrugated furnaces 39 inches in internal diameter and about 6½ feet long. The total grate-surface is 1344, and the total heating-surface 43,264 square feet. When these boilers were designed they were among the largest in the world, although those of the *Campania* are 18 feet in diameter. The plates forming the shells of the large boilers are nearly 1⅛ inches thick and the seams are treble-riveted, the longitudinal joints having a strength of about 80 per cent. of the solid plate. The auxiliary boilers are single-ended, 10 feet diameter, and 8½ feet long, each having two furnaces.



VIEW OF BOILERS FOR U. S. S. "COLUMBIA."

[Diameter, 15 feet 9 inches; length 18 feet; steam-pressure, 160 pounds. Double-ended; four furnaces in each end.]

The boilers are arranged in four groups of two each, and there are four funnels or smoke-pipes,—one to each pair of main boilers. These pipes are about 70 feet high above the grates of the furnaces and 7½ feet in diameter. The compartments which contain the boilers are not only water-tight but air-tight, so as to provide for forced draft by blowing air into the closed space. For this purpose there are sixteen large fans, 5 feet in diameter and 19 inches wide, intended to supply 240,000 cubic feet of air per minute under a pressure of one inch of water (about six-tenths of an ounce per square inch), and to secure the combustion of about 30 pounds of coal per square foot of grate per hour. There are also duplicate feed-pumps in each boiler compartment, one being in reserve in case of accident to the other. These pumps are of the "duplex" pattern, each having two steam-cylinders 12 inches in diameter and two water-cylinders 7 inches in diameter by 12 inches stroke. The main feed-pumps have a combined capacity of about 2000 gallons per minute.

Profiting by the French experiments, the screw-propellers have been placed in the relative positions giving the greatest efficiency. The side propellers, instead of being nearly abreast the rudder as in twin-screw ships, are well forward of this position and distant about 15 feet from the central screw, which occupies the same place as in a vessel with a single screw. In order to avoid any deleterious effect of the race from the side screws upon the central one the side shafts are slightly inclined outwards from a fore and aft position and the central shaft is inclined downwards, with the effect that, on an athwartship plane, the projections of the bounding circles of the screws come clear of each other and the side screws are about four feet higher than the central one. All the screws are three-bladed and have the same pitch, 21.5 feet. The side screws are 15 and the central one 14 feet in diameter. As in all modern screws, the blades are bolted on and adjustable so that the pitch may be altered if, on trial, the first setting is not the best. The screws are made of manganese bronze, a strong and non-corrodible metal, and are carefully smoothed so that the loss from friction may be reduced to a minimum. When it is realized that the tips of the blades pass through the water at a rate of about 35 knots per hour the importance of avoiding friction can be appreciated.

It would require too much space to describe all the auxiliary machinery, for in the modern steamer everything depends upon it,

BOILERS AND THRUST-BEARING AND SURFACE-CONDENSER FOR U. S. S. "COLUMBIA."

—even the absolute essentials, air, water, light, and heat. The use of machinery for distilling and cooling the drinking-water, supplying fresh and removing vitiated air, furnishing electric light and steam heat, has made the modern war-vessel a comfortable home, compared with which the condition of the old sailing-vessels causes a shudder.

The official trial of the *Columbia* occurred on November 18, 1893, and consisted of two runs in opposite directions over a course 43 knots long, off the coast of New England between Cape Ann and Cape Porpoise. The mean of two runs in opposite directions over a short course eliminates the effect of tidal current and gives the true speed, but this is not the case for a long course, so that it is necessary to station observers at short intervals to determine the effect of the tide. The length of the course is chosen so as to require about four hours for the trial, which should not begin until about an hour after the turn of the tide, so as to have the trial completed during one tide and avoid the rapid change in the strength of the current which occurs at both the beginning and the end.

The handling of the vessel and the machinery is done by the contractors and their men, but is under the supervision of naval officers who have control of all the instruments for observing data and who determine whether all the conditions of the contract have been fulfilled. The contract for the *Columbia* required the maintenance of an average speed of 21 knots per hour for four hours, and allowed a premium of $50,000 for each quarter-knot average speed above 21 knots, while there was to be a penalty of like amount for each quarter-knot below that speed. It is evident, therefore, that the contractors have a strong inducement to do everything possible to secure the highest speed. It is supposed by some who are not familiar with the working of powerful machinery at high speeds that it is a very easy matter to earn a high premium. As a matter of fact it requires a combination of circumstances which can only result from perfect design, perfect workmanship, and the highest skill on the part of the men who are running the machinery. The heating of a single journal, the rupture of a pipe, the breaking of a single bolt, and other trifling mishaps to a single part may make all the difference between premium and penalty, and when it is remembered that there are hundreds of such parts, each of which must be perfectly adjusted and looked after with unceasing vigilance, it is seen that the carrying through of a

successful trial and the earning of a premium requires great skill and experience. No contractor dreams of making the official trial until several preliminary ones have shown that everything is in perfect adjustment.

On the official trial the *Columbia* maintained an average speed of 22.8 knots, equal to about 26¼ statute miles. The steam pressure in the boilers was 147 pounds and the revolutions of the screws 134, 127.7, and 132.9 per minute for the starboard, central, and port screws, respectively. The temperature in the engine-rooms averaged 85° and in the fire-rooms 106°. The horse-power of the main engines and auxiliaries was 18,500.

It has been stated that there is reason to believe that three screws are more efficient than two, and this is based on the horse-power required in the *Columbia* as compared with that for other recent ships driven by twin screws. The *New York* furnishes an excellent example, because her hull and machinery were designed by the Navy Department, like those of the *Columbia*, and the same eminent firm built both vessels, so that in each case there was perfection of workmanship and of skill in running the trials. The *Columbia's* model is slightly more favorable for speed, but the talented designers of the Bureau of Construction always give the best lines for speed that the dimensions will permit. The *New York* was about a thousand tons larger on trial than the *Columbia*, but by means of what is known as "Froude's law of comparison" it is possible to determine the speed and power for a vessel of different displacement but where the power per ton will be the same as in the vessel actually tried. In this way we can find what the powers would be for the same speed in a vessel of any given size when driven with the efficiency which obtained in each vessel actually tried. Making the calculation for a vessel of 10,000 tons displacement, it is found that at a speed of about 24 knots the triple screws would have a superiority of about 10 per cent. It would not be fair, from a single comparison, to claim this figure as general, but it shows clearly that there is an increased efficiency.

The *Columbia's* speed of 22.8 knots per hour for four hours is the highest accurate speed for such a period ever attained by any large vessel, but it may be mentioned that the speed was also measured by two "patent logs" of the best type, and the mean of their readings gave a speed of 24.34 knots. Patent logs do not give accurate results, but the record still has a value because the speeds of British war-vessels, with which our own are constantly

compared, are obtained in that way, so that in such comparisons the *Columbia's* speed should be taken as 24.34 knots. This figure is far above the similar record of any other large vessel.

A comparison is naturally invited between the performance of the *Columbia* and that of the fast transatlantic liners, and statements have appeared attempting to discredit her in advance of her trial because her sea speed had been guaranteed at 21 knots, while the *Campania* and the *Lucania* are credited with over 22 knots, the latter being given a record of 22½ knots for twenty-five hours. Inasmuch as the *Columbia* has a *real* speed of 22 8 knots *at sea*, she has beaten the *Lucania*, and the sea was not a mill pond by any means, as the trial was made on the day after a heavy blow. There is, however, a very important point to be noticed in connection with the *Lucania's* speed. The speed given her is based on her noon positions on consecutive days *with no allowance for current*, which in fact could not be determined accurately under the circumstances. Now it is a curious fact that the phenomenal single-day records of these fast ships are always made when coming westward, and nearly always when in about the same part of the course. It is well known that on the westward run, for a distance equal to about two days' steaming, there is a favorable current which, at times, is equal to a knot per hour. While the *Lucania* may not have had the benefit of the full strength of this current, she undoubtedly did profit by it, and this must be remembered when comparing her speed with the *Columbia's*, which is the actual speed through the water without any assistance from current.

Great credit should be given to the builders of the *Columbia*, the William Cramp & Sons Ship and Engine Building Company of Philadelphia, for the splendid work they have put upon this vessel as well as the others they have recently constructed for the navy.

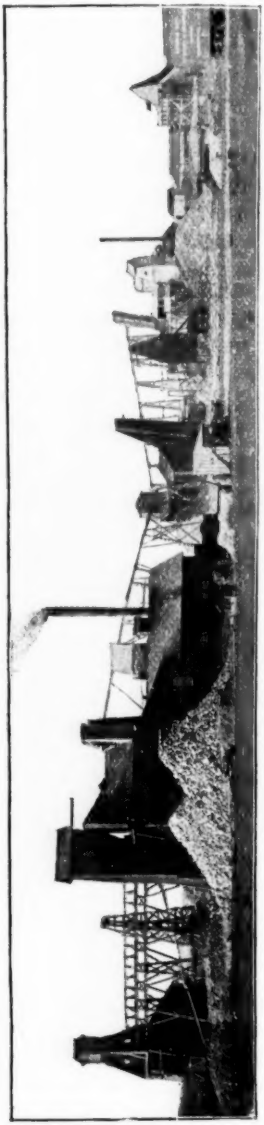
* NOTE.—The illustrations accompanying this article are made from photographs kindly furnished by Messrs. Cramp & Sons.

THE JOPLIN ZINC-MINING DISTRICT.

By Hamilton S. Wicks.

IT has been said of the State of Missouri that, if walled in so as to prevent all communication with the outside world, she would be able to exist independently from the production of her own soil and mines. The State is indeed a nation in itself, when one considers the variety and amplitude of its resources. The soil and climate are most favorable, the natural transportation facilities are unsurpassed, and valuable ores, coal, building stones, and clays abound. The annual value of surplus commodities produced within the State, and marketed by rail or river, exceeds $125,000,000, as shown by the returns of the transportation companies. Among these surplus commodities the item of zinc deserves special mention, for the reason that the State is now producing at the rate of fully two-thirds of the yield of the whole country, and more than one seventh of the world's production. The Missouri product of spelter in 1893 reached 53,636 tons (of 2000 pounds), while the total production of the United States was 80,454 tons. Nearly all of Missouri's yield of zinc comes from the Joplin district, in the extreme southwestern portion of the State. The zinc-fields extend into southeastern Kansas, and embrace an area of sixty by thirty miles; yet the great bulk of the production comes from a rich district within a radius of ten miles from the city of Joplin as a center. The spelter turned out of the furnaces of Illinois, Missouri, and Kansas all comes from the ores of the Joplin district, while the spelter from furnaces in the east and south is made from other ores.

The discovery of zinc-blende in this region was made about twenty-three years ago, in connection with the lead-mines opened by Moffet and Sargent in a creek-bottom now embraced within the limits of the city of Joplin. From the beginning the production has increased steadily, and although the crude methods of mining and treating the ores still prevail to a great extent, they are in many instances being supplanted by modern appliances, and the prospective importance of the region is such that the attention of the whole world interested in zinc and zinc-mining has been forced to it. This region may seem very remote and inaccessible to the

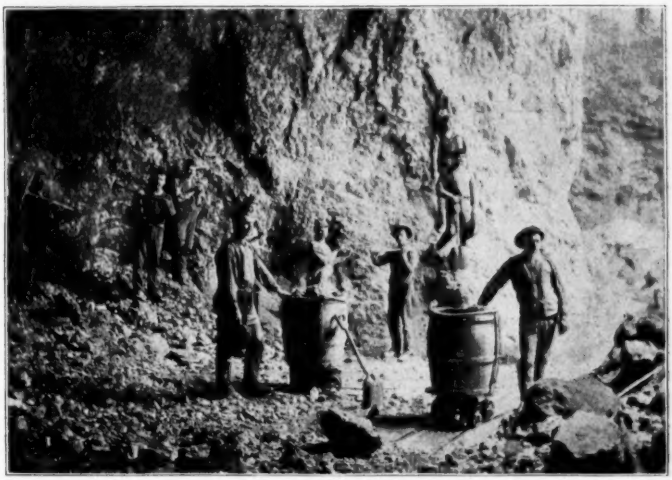


GROUP OF ZINC-MINING PLANTS ON THE "THOUSAND ACRE TRACT," JOPLIN, MO.

people of the eastern States and of Europe, but it will appear less so when it is stated that the center of the district is traversed by four important lines of railway—the Missouri Pacific, the Atchison, Topeka, and Santa Fé, the Kansas City, Pittsburgh, and Gulf, and the Kansas City, Fort Scott, and Memphis—and that the population which has been attracted to this section is supplied with most of the conveniences of modern civilization. The city of Joplin is barely twenty-three hours from Chicago and only fourteen hours from St. Louis.

The entrance to this zinc region is made abruptly at Webb City, Missouri, and Galena, Kansas,—the outlying portals to the Joplin district. Up to the very moment of entering either of these camps there is no suggestion of mines in the whole landscape. There are no mountains here, the Ozarks being many miles further east. Even the foot-hills begin in the adjoining county of Lawrence, in Missouri. The country here is gently undulating, and well-cultivated fields of grain, interspersed with patches of timber, conceal the rich deposits of mineral. At Webb City and Galena, however, all is changed as if by magic, and the rough, coarse underside is exposed. The view presented to the traveler on every side is of innumerable piles of white flint rock of pyramidal shape, varying in height from ten to fifty feet. Above, around, and among these piles ex-

tend long lines of wooden "flumes," while towering above the whole is an interminable array of shaft-houses, hoister-derricks, and smokestacks. It is altogether the liveliest picture presented by any mining-camp outside of the silver and gold regions of the Rocky mountains. A closer inspection of this chaotic assemblage of flint dump piles will reveal behind every heap a shaft sunk into the earth, from which the crude ore with the gangue rock is being hoisted to the surface,—in some cases with the aid of steam or electricity, and in others by the original method of operation by horse-power.



UNDERGROUND VIEW IN A JOPLIN ZINC-MINE.

The first car load of this material was tested at the zinc-works at La Salle, Illinois, where it was found to be zinc-ore of a high grade. But the twenty tons embraced in this shipment returned only $15 net, or 75 cents per ton. Shortly after, $3 per ton was offered, with an early advance to $7 or $8 per ton. A record of the amounts sold from the Joplin district and the prices paid during the period between the years 1873 and 1893 has just been compiled by J. R. Holibaugh, M. E., from which it appears that 960 tons of zinc ore were sold during 1873, at an average price of $9 per ton, bringing in a total of $8640. The rate of output and the proceeds per ton increased steadily during the next ten years, the

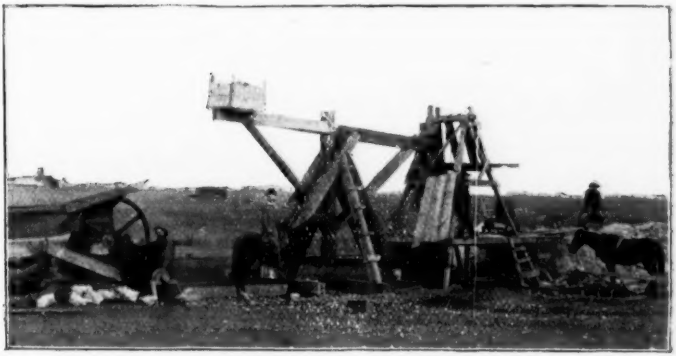
PRIMITIVE HORSE-HOISTER IN JOPLIN DISTRICT.

figures for 1883 being 52,200 tons at an average price of $16.90, or a total of $882,218. During the past ten years the same steady increase in the amount and value of ore has been recorded, with some fluctuation recently owing to the financial stringency prevailing throughout the country. The production for 1893 reached 134,090 tons of ore, at an average price of $19.25, or a total of $2,581,232. The total output for the twenty-one years has aggregated 1,265,119 tons, representing a value of $26,781,580. It is fair to assume that with the return of prosperous business conditions generally, and with the new uses for zinc in commerce which now seem near of realization, the production will be very greatly augmented in this district during the next decade.

The deposits of zinc ore in the Joplin district occur in chambers apparently along subterranean waterways, at a depth averaging from 60 to 170 feet, as at present mined. But millions of dollars' worth have been taken out at a shallower depth, and it is expected that much more will be mined at a greater depth. The ore is found in conjunction with broken-up flint rock, to which it is cemented or through which it is disseminated. The country rock is Keokuk limestone. Geologically the district is sub-carboniferous. Deposits of lead are found nearer the surface and the zinc underneath, although more frequently the ores are mingled

indiscriminately in a conglomerate mass of limestone, chert rock, delomite slate, pyrites, shales, and calcite.

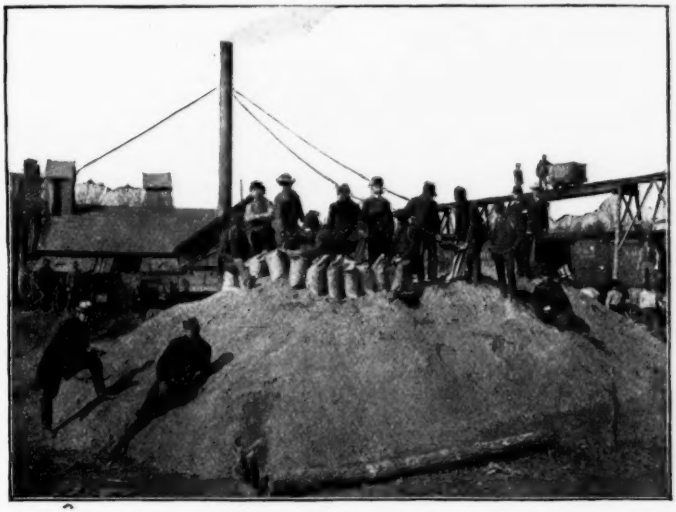
The system of developing lead- and zinc-mines in Missouri is an outgrowth from the necessities of the situation. An old miner once said to me: "This country has been built up by ignorance and poverty; ignorance brought us here, and poverty kept us here." There was little capital at first, and less machinery, but an abundance of muscle and brawn, so that the lease and royalty system early found favor. The system is founded on the supposition that a man's time here is worth nothing unless he strikes "jack"—the local name for zinc-ore—and then it is worth exactly what the "jack" is worth, after deducting all expenses and paying the royalty. The landowner leases his land, commonly in forty-acre tracts, to a company or an individual, on a royalty from 10 to 22½ per cent. of the value of the zinc-ores mined, and 20 to 40 per cent. of the value of the lead-ores mined. These mining leases run usually for ten years. A shaft is sunk for ore, and when it is found in paying quantity one of the prospecting shafts is put down to a sufficient depth to drain the property. The miner hoists, crushes, and washes his ore on the ground, and sells it to agents of various smelters located in different parts of the country. Money for all ores passes through the hands of the landowners. They retain the royalty due to themselves and the miner receives the balance, out of which he pays all the expenses of mining, crushing, cleaning, and hauling. The system of sub-leasing small parcels of land to actual miners prevails to a large extent. Parties who have leased forty acres or



CORNISH PUMP IN GENERAL USE IN THE JOPLIN DISTRICT.

HAND-JIGGING AT A JOPLIN ZINC-MINE.

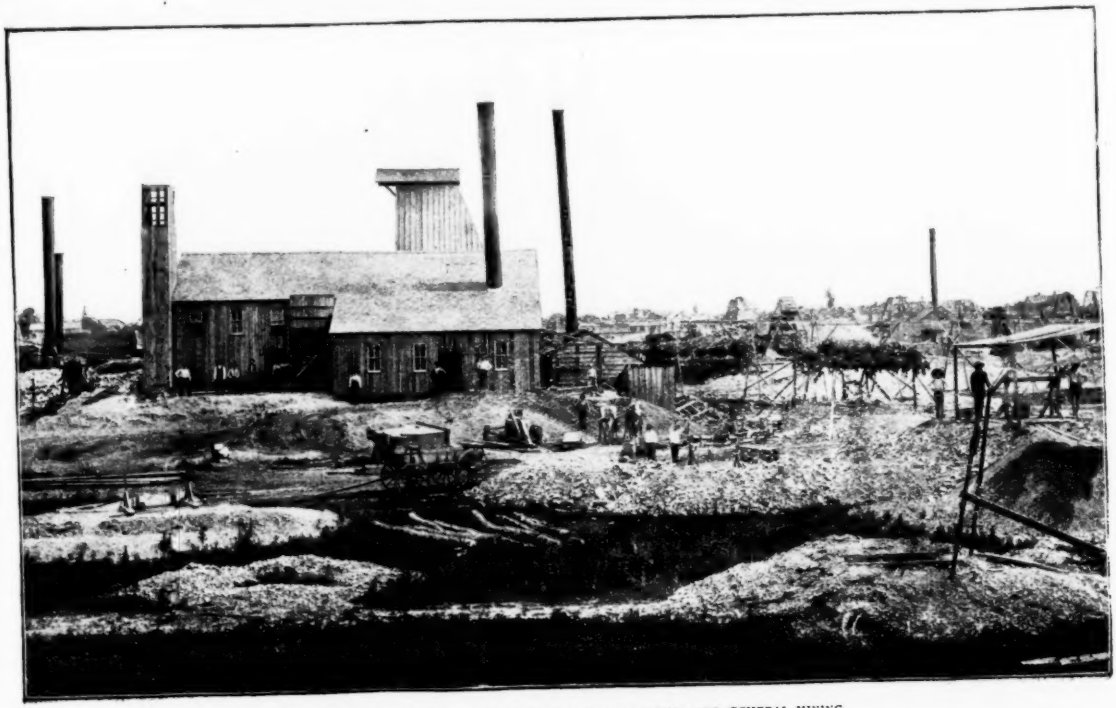
more lay off the land into miners' lots 200 feet square, which they sub lease to actual miners on a royalty of 20 per cent. or more. When a miner is not successful in finding paying ore or when, owing to the want of capital to provide proper machinery, the ores are too poor to be profitably hoisted and cleaned by hand, he stops work and forfeits his lot,—usually at the expiration of ten days. Many shafts that are sunk for ore prove a disappointment. Drill-holes are frequently put down that strike nothing but lime and flint. Even some that indicate ore fail to show any when the shaft is sunk. There are failures and successes in zinc-min-



SACKING ORE FOR SHIPMENT TO EUROPE.

ing as in every other kind of business. Much depends on the exercise of good, practical, common sense.

These mining leases compel the miners to work continuously and to crib and timber in good, workmanlike manner. Some of the miners, endowed with more business sagacity than others, have become able to invest in machinery to hoist and dress their ore, and these have in time become capitalists with fortunes of from $50,000 to $200,000. Still others have become very wealthy, owning large tracts of land and profitable mines, the builders of



"SUCKER FLAT" (JOPLIN, MO.), SHOWING THE NOBLE MILL AND GENERAL MINING.

handsome business houses in Joplin and neighboring towns, and the possessors of handsome residences.

At Galena, Kansas, the school-board erected a handsome building from the 10-per-cent. royalty received from mining on one of the school lots, and a church there pays the pastor's salary and keeps the church in repair from the royalty from mining on the church's ground. Shaft No. 1 on the Allen land, near Joplin, has produced over $100,000. The Richland Mining Company have extracted from two lots $109,144. The Ealer land (forty acres) of Carterville has yielded fully $400,000. The Perry forty has yielded since June, 1892, $76,196. The production of the Tracy mines aggregates $1,000,000. The pump-shaft of the Cohinore mine, within the limits of Joplin, has averaged 200 tons of rough ore per week for the past two years. The two celebrated Poundstone lots in Carterville have turned out over $750,000 worth of ore, and the ore is not yet exhausted. The Southside mines of Galena have yielded over $2,000,000, and the Center Creek mines have yielded over $4,000,000. This list might be extended to a great length.

Three miles southeast of Joplin in September, 1891, the Rex Mining and Smelting Company put down a drill on their "thousand-acre tract," striking zinc at a depth of forty-five feet. Other drill-holes were sunk in quick succession, with the result that there was a rush of outside miners anxious to make leases at a royalty of 20 per cent. The output of ore increased steadily until "high-water mark" was reached during the week ending November 25, 1893, when the product was 864,030 pounds of zinc-blende and 36,290 pounds of lead. The entire production of this tract which, by the way, was mined from less than a hundred acres of the ground, had reached at the date named more than 10,500,000 pounds of zinc-blende and 1,750,000 pounds of lead, selling altogether for $400,000.

A thirty-acre tract of land located in the suburbs of Webb City and known as "Sucker Flat" is said to have derived its name from the Hon. John W. Noble, the secretary of the interior in President Harrison's cabinet, who was the supposed "sucker" in the case. In 1888 some over-shrewd parties induced Mr. Noble, then an attorney in St. Louis, to pay $500 for four acres, under the representation that it was good mineral land. As soon as the money was paid the parties interested, with a general guffaw, designated the property as "Sucker Flat." Soon the original owners attempted to recover the land by paying double

the price for it, but the laugh was now on them, while Mr. Noble came to be regarded as unusually keen at a bargain. As prospecting continued to reveal the character of that section he was offered $12,000 for his little purchase, but he has already collected much more than that in royalties from the ores mined from his four acres, which continue to be large producers. The total production for what is still called "Sucker Flat," including the ten acres of the Center Creek Mining Company, reaches to date $1,250,000.

Not far from Joplin is a twenty-acre tract of ground which four years ago was practically unknown to miners, and the owner, a lady in an Indiana village, doubtless would have accepted $10 an acre for it. Zinc-ore was accidentally discovered on this tract in 1890, and in three years the production had aggregated $300,000. The picture entitled "Sacking Ore for European Shipment" represents a view on Mrs. Allen's land when a shipment was being made to Messrs. Vivian & Son, at Swansea, Wales, of 1000 tons of zinc-ore, assaying 60 per cent. and better. The price paid for the ore averaged $24 per ton net to the producer.

A visitor to one of the zinc-mines in this region may be invited to go down a shaft offering nothing but a dirty tub as a means of descent. Into this one foot is thrust, while the other is used to guide the tub, to keep it from catching on the timbers which line the shaft. At a depth of say a hundred feet the tub comes to a stop, at the mouth of the drift in which miners are at work extracting ore. Below this point in the shaft is the "sump," which, until the visitor's eyes adjust themselves to the darkness, may be imagined to be bottomless, though only ten or fifteen feet in depth. Once in the low and narrow drift one walks as much as possible upon the rails of a little tramway which conveys the ore from the head of the drift to the shaft. The passage-way is usually dripping and muddy, and one needs the protection of a rubber coat and boots which may be borrowed from an accommodating miner. The drifts of the mines in this region extend from 100 to 500 feet, and one soon reaches the end where the brawny miners are working with pick and shovel. As the lights are held close to the wall of the drift, it does not require an expert to detect the glittering crystals of zinc-blende and lead, intermingled with the flint rock and the limestone. The theory of geologists that the zinc-blende was deposited by metalliferous waters coming up through crevasses and veins, and spreading out through these beds of broken flint and lime, seems verified by the fact that miners' tools

left in old mines have been found long afterward covered with zinc crystals, formed from the waters that have dripped on them. Analyses of water here have shown thirteen grains of zinc per gallon of 231 cubic inches.

As before intimated, the primitive methods of hoisting the ores do not prevail in all the shafts; nor does the hand jig serve in all cases for handling the ore after it reaches the surface, although it is still largely in use. The hand jig, as shown in one of the engravings, consist of a wooden plank box, six feet square and three feet high, which is nearly filled with water. Into this is hung a sieve-box, two by five feet, and eight inches deep, to which is attached a pole about sixteen feet long. The miner, seizing the end of this pole and raising his hands as high as possible above his head, jumps up and down rapidly, giving a sharp, jerky motion to the pole, thus agitating violently the contents of the sieve. The sieve is filled with crude ore direct from the mine after it has passed through a simple Blake crusher and a pair of Cornish rolls. The process of jigging causes the heavy ore to settle to the bottom of the sieve-box, when the lighter ore is shovelled off to the waste-pile. One good man operating a cleaning-jig will be able to turn out 1½ tons of clean ore in a shift of nine hours.

Of late several steam concentrating-plants have been erected. The ore is run by an elevated tramway directly from the mining-shaft into the mill, where it is dumped upon a large platform and at once shovelled into the crusher, only the larger pieces of chert rock being culled from the general mass. Practically everything hoisted goes through the crusher and Cornish rolls without previous treatment. From the crusher and rolls the crushed stuff is conveyed to a revolving screen and thence to the steam jigs, which consist usually of five "roughers" and six "cleaners." The principle of operation of the steam jigs is the same as that of the hand jigs. The rough ore crushed and screened is made to flow with a sufficient volume of water over the jig sieves, which are rapidly agitated by plungers attached to an eccentric shaft operated by steam-power. The heavy ore is carried to the bottom by gravity, while the light stuff remaining on top is washed off into the "tailings." These jig-boxes are tapped at the bottom at intervals and the cleaned ore taken to the bins. The common concentrating-plant of this region, while running on 10-per-cent. "dirt," will clean seventy-five tons in two ten-hour shifts, placing 7½ tons of cleaned ore in the bin. These plants cost about $10,000 and the cost of

operation does not exceed $30 a day. The rough ore from the mines will average about 10 per cent. of zinc-blende throughout the district, although the dirt from many mines yield fully 25 per cent. The assayed value of metallic zinc in this ore runs from 57 to 62 per cent. Of this metallic content 80 per cent. is saved by smelting in the ordinary Belgian furnace. The cost of mining will average very nearly $10 per ton throughout the district. The cost of smelting varies from $8 to $10 per ton. When the zinc-ore has been smelted it enters the market as spelter, containing on an average less than 2 per cent. of foreign substance.

The mining of zinc as practiced in the Joplin district is a most fascinating business. The results are so immediate and so apparent that the most inexperienced person can readily comprehend them. The slight depth at which ore is struck and the simple methods which can be made available mark a great contrast when measured by the deep mining of Nevada and Colorado, with their ponderous pumps and crushers and complicated stamp-mills and concentrating machinery. Not only is the return very great, compared to the amount of effort expended, but the result is permanent, the output of a given shaft lasting perhaps for years. Zinc-mining is an industry with a yield as certain and steady as the corn or wheat crop, with the advantage that a new crop is gathered weekly instead of once a year, and that it is practically in shape of actual money injected into the channels of commerce in this vicinity. It is so nearly like getting something for nothing as to afford a fascination,—or, in colloquial phrase, a "mineral fever," —which will catch a millionaire as quickly as it will a poor man.

The principal use which has been found in America has been for galvanizing iron as a protection against rust. Its utility in this connection is so manifest that it is used to galvanize not only all sorts of architectural iron-work, but also barb-wire, which it renders threefold more lasting. It is also largely used in manufacturing brass. The increasing use of electricity has increased the consumption of zinc in a large degree. It is used in desilverizing processes, in lithography, and for glazing paper. It is used in the making of domestic utensils, toys, buttons, packing-cases, stamped work, refrigerators, for sheeting vessels, and a multitude of other purposes. In Europe zinc finds its most general consumption as a roofing material, for which it is especially adapted. It would seem an easy matter, to find favor for zinc for this purpose in the United States.

OFFICIAL ARCHITECTURE IN AMERICA.

By Montgomery Schuyler.

IT is perhaps as much a political as an esthetic reflection that, while public architecture in every other country fairly represents the best that the architects can do, in the United States it is very apt to represent the worst. There is at any rate no doubt about the fact. The professional goal of a practitioner of architecture in France—the goal which he sets before himself even at the beginning of his studies, and to which his studies are largely directed—is an appointment to be a government architect. The centralized system of administration that survives all political changes makes the public architecture an official function. Not only would the notion of employing an obscure architect to design a public building be resented by the public, but the execution of such a notion would be quite impossible. An architect must prove his ability according to the tests imposed by a professional education which is itself the care of the State, and also in private practice, before he can be so much as considered when there is a question of designing an important public building. The result is that, whatever may be thought of a new public building in Paris or in the provinces, there is never any doubt that it represents what the official hierarchy and the public alike consider the acme of professional attainment. Throughout continental Europe the rule is the same. In the British islands, where the popular agreement that the arts will flourish best if the government leaves them alone is largely the expression of a popular indifference whether they flourish or not, it is still true that the public architecture represents the best that the architects can do. From the time of Sir Christopher Wren to that of Sir Gilbert Scott the architects who have stood highest with the cultivated part of the public have been the architects chosen to do the government work.

Westminster Palace is not an object of unmixed national pride, but Sir Charles Barry was at the head of the profession when it was designed, and, although in the light of what has been learned and done since it is rather a queer example of secular Gothic, it embodies as much of Gothic as was understood at that time among the leading architects who resented and resisted the revival that

was really imposed upon the profession by the public, and of which the origin was in part archæological and in part ecclesiological.

Undoubtedly the Gothic revival is not seen at its best in public buildings. It was begun by the Houses of Parliament, and it may be said to have been definitely closed, so far as secular work goes, by the erection of the Law Courts. The world is pretty well agreed that this latter building is a failure, both practically and artistically, and yet it was certainly not a failure for lack of pains,—of far more pains than have ever been taken to secure in America a work of official architecture that should be the best that the architects could do. The competition for the Law Courts was a model of liberality and consideration. The invited competitors were the architects most in view, and the architect finally chosen was one of the most eminent of these. Moreover, it was one of the most interesting architectural competitions that has ever been held, and Mr. Burgess's design was probably the very finest achievement of the Gothic revival, and had more influence upon the practice of his contemporaries than any modern building actually erected in England, having very evidently supplied the architectural motive for buildings on both sides of the Atlantic. It is noteworthy, however, that Lord Palmerston actually interposed to dictate the style of a public building, against the protest of its architect, and insisted that he would not have Gothic, but would have "something light and airy." It would have been out of the question for such a question to be decided in any other country than England, always excepting our own, by a layman's freak, and this official freak was especially deplorable because Sir Gilbert Scott, if he had been left to his own devices in the design of the Foreign Office, might very possibly have produced a more worthy monument of the Gothic revival than any that it has left in the shape of a public building. Since the close of the Gothic revival no public building of the first importance has been erected in England.

If such a building were projected, however, an attempt would be made, we may be sure, to make it worthy of the best that the nation could do. There would not be that complete indifference whether it was good or bad that characterizes our own productions in this kind. Undoubtedly during the past quarter of a century the government of the United States has erected more buildings for its own use than the government of any other country in the world. It has spent more money upon architecture and got

less architecture for its money than any nation of past or present times. The waste is appalling when we come to think what might have been done with this money if the standard of official architecture had been kept up to the standard even of the best private building. If we had had a bureau of public works with a succession of able and responsible architects at the head of it, it would have had by this time a tradition of its own that would have been of immense value to the architecture of the country. For the national building in any town is sure to be a conspicuous building. With the system now firmly established in Congress of log-rolling for building appropriations, and of erecting in villages public buildings suitable, in scale and cost, for the cities these villages are expected to become, it is apt to be the most conspicuous building, and the pioneer and model of edifices built of permanent materials. And what models they have been, these public buildings, from the time of Mullett and earlier! With one or two distinguished exceptions the supervising architects have not been men of high professional standing, although they have been quite as eminent as could have been expected from the conditions of their service. Indeed, the status of the supervising architect is a measure of the legislative, and consequently of the popular, appreciation of architecture. That functionary has the spending of far more money than any private practitioner. He has the supervision of ten times as much work as any conscientious private practitioner would consent to be responsible for. Yet his status is that of a clerk and his compensation such as would not tempt an established practitioner, unless such a practitioner were sustained by professional enthusiasm and willing to make sacrifices for his art. Even so his sacrifice would be vain. A busy architect in private practice has far too little time to devote to the art of architecture. The supervising architect of the treasury, if he discharges the responsibilities his office imposes upon him in other respects, can have none at all.

The increase of these responsibilities with the increase of the public building has put it quite out of the question that the supervising architect could, in any proper sense, design any of the buildings he is directed to erect. This was the sufficient motive and justification of the bill providing for the opening of the design of public buildings to competition, a bill to which many architects, having the honor of their profession and the architectural credit of the government at heart, devoted much unselfish labor. But the measure was shorn of nearly all its purpose and effect by

the amendment that was foisted upon it, forbidding the secretary of the treasury to pay for the services of any of the architects whom he was authorized to select as competitors, except the architect whose design was chosen for execution. Nothing could show a more complete misapprehension of the purpose of the bill than this amendment. It is true that the architects at large are responsible for this misapprehension. So long as men who call themselves architects can be got to do work for nothing and submit their designs as chances in a lottery, so long will men who are unaware that there are architects and architects, and that the work of some is more desirable than the work of others, be unwilling to pay for what it seems to them they can get for nothing. Architects of repute will sometimes consent, whether or not they are well-advised in consenting, to enter open competition for public works, when they are assured of competent judgment upon their designs, and when the prizes are numerous enough and large enough to give a reasonable chance that they may be reimbursed for their actual outlay. But it is perfectly well known to private builders that architects of repute will not submit their designs to lay judgment unless they are paid for preparing them. What the government of the United States refuses to do every corporation that projects a new office-building, and that desires to have a choice of designs, finds it necessary to do. It may be as well, with the law that was framed to bring about a better state of things thus shorn of its force, that the secretary of the treasury should have declined to avail himself of the permission the law gives him to invite people to do work for the government for which he is forbidden to pay, and should prefer to go on entrusting the public architecture to the system that has already left it far behind private building.

How far it is behind may be judged from the comparative exhibit of the two that was made at the World's Fair. It was a most impressive object-lesson, the comparison between the buildings reared by private enterprise, under an exceptionally fortunate direction, it is true, and the building erected by the government to represent it to its own citizens and to foreign visitors. If the American people were not capable of learning the lesson there put before them ; if even a representative or a senator could not see the difference—then it is quite idle to hope for any change for the better in our official architecture. While the practice of architecture, as shown in the academic exercises that a singular good fortune enabled to be actually reared in Jackson Park, has been stead-

ily advancing in the country at large, the official architecture of the country has been as steadily deteriorating, until now it has relapsed into positive barbarism. It was not so in colonial times, or in the early days of the republic. Then the public buildings were the best that we could do. The old "Federal Hall" in Wall street impressed a British visitor of just a century ago as the only edifice in New York worth looking at, and within a generation afterwards such public buildings as the City Hall of New York and the State House of Boston showed that the State understood and desired the best that its citizens could do. Nay, take as a standard of comparison the public buildings at Washington, and draw the line at the middle of the century. With all their defects and inequalities, the public buildings erected before that date did really represent the highest architectural attainment that was available at the time. Who that has seen both Washington and the World's Fair, even if he be a member of Congress, can fail to perceive that it would be for the credit of the country if the existing public buildings at the capital were to be replaced by structures erected from the designs of those architects whose work was shown at Chicago? We are not saying that the formal and academic style that is common to the public buildings and the exposition buildings would be desirable for adoption in permanent and representative buildings of our country and our time. But precisely because their classicism is common to both, a just comparison can be instituted, and the comparison is at every point favorable to the later designers. There is juster proportion, more dignity, more breadth, more stateliness, more repose in the general composition of their works, as there is more refinement, more purity, a nicer adjustment and scale in the detail. In a word, they show more architectural quality. On the other hand, let anybody figure to himself a new group of public buildings at the capital by the author of the Government building at the Columbian Exposition! The imagination of the untutored observer must recoil from such a prospect. For stateliness, it shows pretension; for distinction, commonness; for repose, restlessness; for elegance, crudity. It is in this comparison the work of barbarians impudently confronting the monuments of a high civilization. Nay, there is scarcely a comparison that can be made upon the Fair-grounds, except with the very crudest and most illiterate of the State buildings, and not with more than two or three even of them, by which the government of the United States does not appear to disadvantage.

And yet, under the system that has grown up with the acquiescence of our lawmakers, it is not to the architects of the Court of Honor but to the architect of the Government building that we should turn in case it were necessary to add to the public buildings of the capital. The deterioration in our official architecture has been at least as progressive as the advance in our private architecture. The latest of the great public buildings, happily, is the building of the State, War, and Navy departments, one of the works of Mr. Mullett. It argued a deep architectural insensibility to add this fussy and multifarious structure to the collection of simple, quiet, and decorous public buildings at Washington. And yet itself becomes respectable and almost distinguished when it is compared with the government's exhibit of its official architecture at the World's Fair. The protest that the sensitive visitor to Washington feels called upon to enter against the intruder upon its peace, the shade of Mullett would be entitled to repeat against bestowing upon his work the neighborhood of a newer building by the author of the Government building at the World's Fair.

And consider that the quality of the Government building at the World's Fair is the architectural quality of the work that the government is doing all over the country, and spending more money upon, year after year, than was ever spent upon architecture by a single nation. There is much to be said about the official architecture of our lesser political divisions,—of States and municipalities. The rule is that no official person cares about it, or takes thought for it, and the rule consequently is that it is pretty bad. But the rule is mitigated by occasional exceptions. In any case, and if there were no exceptions, the mischief that is done by the workings of officialism in the architecture of States and municipalities would sink into insignificance compared with the mischief that is done in the architecture of the national government. We are spending enormously and profusely every year to pervert the perceptions of the people of the United States respecting the art of architecture. What can the beneficent influence of a group of monumental buildings in transitory plaster of which a fraction of the people have had the vision for a day or two do to counteract the malign influence of permanent buildings, in the sight of which the people pass their lives;—an influence that reaches into every quarter of the land, and into every Congressional district that exults in an enterprising member who insists that his constituency shall have its share of what is going?

ELECTRICITY

Conducted by Franklin L. Pope.

THE fire-losses in the United States for the year 1893 are variously estimated by the insurance experts at from $150,000,000 to $190,000,000, being something like $25,000,000 in excess even of those of 1892, which was regarded as one of the worst years in the history of the business. It is asserted that the entire fire-insurance business of the country for the past twenty years has not paid a dollar of profit to the underwriters, the credit balances of the few successful companies being much more than offset by the losses of the others. An effort is now being made by the New England Insurance Exchange to ascertain the classes of risks which have been notoriously unprofitable, and to increase the rates on such property to a paying basis. Whether rightfully or not, it is certain that the insurance companies are becoming more and more disposed to attribute the enormously-augmented fire-losses of late years to the increased use of electricity. It is peculiarly difficult, however, for various reasons, to get at the truth of the matter. Every well-informed electrician is perfectly well aware that from all low-tension direct-current systems of electrical distribution, especially those which are not insulated from the earth,—as is almost universally the case with electric-railway circuits,—there is constant and imminent danger of fire, unless all the wiring and fitting has been carefully and intelligently done and is kept under constant inspection. On the other hand, with the alternating system, which has become almost universally employed for lighting, experience has shown the fire-risk to be very small. That the increased losses of late years, if attributable to electricity at all, must be due to defective and careless construction, would seem to be proved by the fact that no especial complaint appears to have been made by the underwriters in the large European cities, in many of which the use of electricity has become as general as it is in those of the United States.

THE great number of electric-light and -power stations which have been destroyed by fire during the past few years is doubtless one thing which has had much to do with the present attitude of the underwriters. The fact that so many disasters of this kind have occurred inevitably raises a presumption that there must be something peculiarly hazardous in connection with the machinery and processes for generating electricity. Yet in the majority of instances within the knowledge of the writer such fires have originated from some cause wholly unconnected with the electrical machinery. It is difficult to understand the incredible folly of many of the electrical companies in housing large quantities of expensive machinery in combustible buildings. There will be found buildings with wooden floors saturated with oil; dynamo-belts, often running from one floor to another, likewise saturated with oil; rooms ceiled and sheathed with yellow-pine boards; switchboards of varnished wood, and so on. A central station is nothing more than a large shed; hence it is by no means unreasonably expensive to build it with brick walls, an iron roof and a non-combustible floor, or to make use of slate or marble switchboards and fireproof wiring; yet such construction in this country is the exception and not the rule. As we write a flagrant example of this particular variety of imbecility presents itself, in news of the destruction of a large power-station situated midway between two thriving Massachusetts towns, to both of which it fur-

nished not only light, but also motive-power for twenty-five miles of street-railway. The building was set on fire by the explosion of a hand lantern, and the flames spread so quickly that the employés barely escaped with their lives, with the loss of all their effects. In this case nearly $75,000 worth of valuable machinery was destroyed, while the loss, inconvenience, and danger to the communities who depended upon the establishment for light and transportation is a serious item. Only a few months ago a new station in a New Jersey city of 50,000 inhabitants was burned in almost the same manner, but the warning was of no avail; the station has been rebuilt with new machinery exactly as it was before, and doubtless will be burned again within the next five years. Unless an electric company can afford to put up a fireproof building for its central station it has no business to ask the community to patronize it; the entire municipality may be left without light and power at a moment's notice and the gravest inconveniences and dangers may ensue. If the underwriters should finally conclude to refuse absolutely to insure electric stations it might possibly be an advantage to the public as well as to themselves, if the present aspect of affairs is to continue.

THE Metropolitan Traction Co. of New York has generously offered a prize of $50,000 to any inventor who, before March, 1894, shall bring forward a system of propulsion for street-railway service which shall approximate the trolley as a standard of economy, but shall be without features "objectionable to the public." This is clearly an impossibility. No system of improved transit,—no other improvement whatsoever in any public service,—can be devised by the wit of man which will not be in the highest degree "objectionable" to the enlightened managers of the New York daily newspapers. As the so-called "public" really has no idea whatever in reference to such matters, but merely crude notions and senseless prejudices which are derived from a hasty perusal of the "scare-heads" of the above-mentioned manufacturers of alleged "public opinion," it is evident that the Metropolitan company is in no immediate danger of being compelled to part with its $50,000. We suggest, by way of amendment, that New York city be ruled out of the competition.

THE message of Governor Flower, of New York, and the annual reports of the State engineer and superintendent of public works have made their appearance. Each of these officials has considerable to say in reference to the question of the application of electricity to the propulsion of boats on the Erie canal, but it must be confessed that they have thrown very little new light on the subject. Briefly, the governor seems to be of the opinion that, inasmuch as the present canal is not worked nearly to its maximum capacity, it is not worth while to increase its depth until the present cost of transportation has been materially lessened by the application of electricity. This line of reasoning appears to us to be fallacious. The question of the enlargement of the canal is one thing, and the question of the best motive-power to be used on it is another. Every engineer, as well as every practical canal-man, understands perfectly well one thing which the governor seems to have overlooked: that neither electricity, nor steam, nor mules, can move a boat either rapidly or economically unless there is plenty of water underneath it. The canal is not worked to its capacity simply because it does not pay well enough under existing conditions to induce additional capital to embark in the canal freighting business. If there were only a foot more depth of water horse-boats could make seven trips per season with certainty, where they now seldom make more than six, and even at the present low rates of freight,—which, by the way, are obviously due to the competition of the four-track New York Central railroad, and not to that of the steam-barges,—would then be able to make a fair profit where they now lose money.

THE report of the New York State superintendent of public works contains some further information, which only serves to

deepen the mystery which envelops the real object of the exhibition at Pittsford a few weeks ago. The capability of electricity to propel a boat with efficiency, and especially with economy, was sufficiently demonstrated, if indeed any demonstration were needed, by the magnificent record of the electric launches at the World's Fair, recently referred to in this Department. Yet the electrician who watched the canal experiment in behalf of the State officials makes the astounding report that no less than 5.35 electrical horse-power were required merely to revolve the propeller when out of the water, and that the aggregate loss from friction in the machinery and from inefficiency of the electric motors was actually 20 per cent. of the gross power expended! We have heretofore adverted to the absurd inaptitude of the devices employed to convey the current from the trolley-wire to the boat. The total expenditure of power required to attain a speed of 2.65 miles per hour, against a head-wind and the ordinary current of the canal, is given as 24.87 electrical horse-power. Inasmuch as two boats each of the same capacity are towed at an average rate of 1.5 miles per hour by a team of three mules, it is obvious that the Erie-canal electricians will have to do better than this to stand much of a show in the way of competition. The conjecture may perhaps be hazarded that the Pittsford demonstration was intended to be nothing more than the forerunner of some measure which in due time may make its appearance in the legislature, conferring upon a favored corporation the exclusive right to supply electricity to the canal boatmen. It is to be hoped that nothing of the kind will be done. If it be decided to introduce this agency for canal purposes, the State should by all means own the trolley-lines and accompanying structures and regulate their use, while the contract for furnishing electricity upon each section should be awarded, under proper restrictions, to the lowest bidder.

THE observations of State Engineer Schenck in reference to the application of electricity on the canals certainly evince a more intelligent appreciation of the problem as a whole than do those of the other State officials. The problem, as Mr. Schenck clearly perceives, is almost purely an economical one. From the figures procured by him from the Albany electric railway he reaches the conclusion that to obtain one horse-power hour by steam, at a mean distance of eight miles from the power-house, would require from 4½ to 4¾ pounds of coal, which is considerably in excess of the amount now consumed by the canal steamers. He therefore concludes that the transmission and utilization of water-power rather than of steam-power affords the greatest promise of economical success. But in this again he sees a difficulty, in that alternating-current motors must be employed, whereas he states that continuous-current motors alone have thus far proved successful. Mr. Schenck's conclusions are logical enough, but his premises are somewhat at fault. The consumption of power in a street-railway plant furnishes no criterion of what it would be in a system of canal-boats. The waste of power in a street-railway system, due to the irregular and fluctuating loads upon the engines and generators and the varying speeds and frequent stopping and starting of the individual motors, is enormous, amounting at the lowest estimate to one-half the total power generated, while in driving screw-propellers the whole plant, both steam and electric, is worked under conditions of almost ideal efficiency. Then again, the saving in cargo space and in cost of skilled labor on each boat must amount to no inconsiderable figure. The objection that the electric boat must be towed from Albany to New York and back by steam does not appear to us to be an insuperable one; it certainly would cost no more to tow an electric boat down the Hudson by steam than it now does to tow a horse-boat,—namely, $25 loaded or $15 light, or say 10 cents per ton of cargo per trip. The propeller of the electric boat might be unshipped, or suffered to revolve idly in the water, as it need make only a trifling difference in the power required to pull the boat. The total cost, to the canaler,

of transporting one ton of cargo from Buffalo to New York is stated by good authority to be in the neighborhood of a dollar, so that it appears he pays the tow-steamer only one tenth of the whole amount for hauling him nearly one-third the distance. It is not to be expected or imagined that any probable application of electricity will be able to reduce the cost of transportation on the Hudson river below its present figure. As for the alternating motor, it probably will be ready when wanted.

A GENTLEMAN whose name has been prominently mentioned in connection with the electricity-on-the-canal experiment above referred to makes the assertion, in the columns of a technical journal, that steam has been in competition with horse- and mule-power upon the Erie canal for many years, and that "statistics" show that up to date the horse and the mule are ahead. Anything may be proved by statistics, but a former report of the State engineer gives the number of steamers as follows, steamers having been introduced in 1872: in 1874 there were 15; in 1878, 19; in 1883, 92. The number now in the service is not officially given, though a greater or less number have been built every year since, which does not look as if steam was altogether a failure. In 1891 a careful estimate of the actual cost of transportation on the Erie canal was made by John Bogart, State engineer. It was found that a four-boat steam fleet could carry grain from Buffalo to New York at a net cost of 2.44 cents per bushel, while the cost by double-header horse-boats was from 2.94 to 3.23 cents, according as the boatman succeeded in making six trips or seven during the season. These figures are given in the engineer's annual report and are made up from carefully-itemized statements. If they are correct it is safe to predict that few horse- or mule-boats will be found on the canal in the year 1900.

THE details of the plans of the mammoth electrical power-plant at Niagara Falls, which have been sedulously concealed from the knowledge of American electricians, have at length been disclosed by one of the consulting engineers, Professor George Forbes, in a paper read by him before the British Institute of Electrical Engineers. The dynamos are horizontal, the revolving parts being carried on the upper end of vertical turbine shafts. Each dynamo is to give a current of nearly 1000 amperes, at a potential of 2000 volts. The type which has been chosen is a two-phase alternator, having a speed of 250 revolutions and a frequency of 25 periods per second. The main distributing conductors are bare and are placed on insulators in subways. Professor Forbes's paper evoked what can be fittingly characterized only as a perfect cyclone of criticism, and many of the details of the plan were emphatically condemned by men eminent in the profession. We venture to express the opinion, however, that in the main the results will ultimately be found to justify the plan which has been adopted. Everything points to the two-phase alternator in quadrature as the type of the universal electric-distribution system of the future, and if this is to be the case the only room for a serious error in principle would seem to be in respect to the frequency which has been decided upon for the alternations. This certainly seems very low, as contrasted with ordinary practice, but it must not be forgotten that the distribution of current for illumination is a very subordinate function of this enormous plant, which is designed primarily almost exclusively for power purposes.

THE advent of the new year is accompanied by a wholesale reduction in the price of electric incandescent lamps, lamps made under the Edison patent being now sold in quantities at about 30 cents each, while rival concerns are advertising others as low as 25 cents. This is a matter of more importance to the consumer than he is likely to realize at the outset. Upon the general assumption that a lamp ought to be expected to burn for a thousand hours,—that is to say, for about a year of ordinary use,—the purchase of a lamp for 25 instead of 50 cents does not appear to be very signifi-

cant. But when the question comes to be considered in another aspect,—namely, as to the amount of light that can be produced from a given current in a given time from a dollar's worth of lamps,—it will be seen that the saving in the amount of current that must be paid for by meter is by no means an unimportant matter. A moderate reduction in the price of lamps really means a very large reduction in the price of light. If intelligent advantage is taken of the new conditions many a central station which hitherto has barely paid expenses may soon be put upon a dividend-paying basis.

IF the valuable information in reference to the installation and management of small electric-light stations which is contained in Mr. Talbot's article in the present number of this Magazine could have been laid before the public several years ago, not only might a large waste of capital have been prevented, perhaps, but a great many enterprises of this kind, now struggling under a discouraging burden of financial and engineering mistakes, might by this time have been in a prosperous and flourishing condition. It has been frequently pointed out in these notes that the majority of electric-lighting enterprises in towns of 5000 inhabitants and under, as a matter of fact, earn but little more than their expenses. Most of them have been unskillfully planned; many of them are unintelligently managed, while, as Mr. Talbot clearly shows, the margin between gain and loss is so narrow as to leave but little margin of allowance for errors, either of plan or of administration. While emphatically approving of Mr. Talbot's suggestion that disinterested and competent expert advice should be secured in all cases, before undertaking a work of this kind, we may venture a word of caution: that not every one who arrogates to himself the title of "electrical engineer" is to be taken at his word, without investigation. Within a very short time a number of enterprising citizens in a certain locality in New England formed a company and commenced the construction of a plant with the intention of furnishing electric light to a town of 3000 or 4000 inhabitants. Under the advice of an alleged electrical expert—whose name, by the way, is not found on the rolls of the Institute of Electrical Engineers—four water-privileges were secured, situated at different points upon the same stream, which were "estimated" (though not demonstrated) to have a capacity each of 75 to 100 horse-power. These were situated at an average distance of nearly eight miles from the town which it was proposed to light. A canvass was made for the purpose of securing consumers, and as the lights were to run by water-power, and of course without expense, the prices promised were but little more than half the standard rates in other towns. No allowance for losses in the machinery and transmission were figured, the general manager asserting with the confidence of inexperience that ten 16-candle-power lights could be furnished for each theoretical horse-power at the fall. But when confronted with the problem of assembling the power of the four water-privileges, without installing a complete generating, transmitting, and distributing plant, with its separate outfit of apparatus and attendants, in connection with each water-privilege, it appeared that it had been assumed, as a matter of course, that there could be no practical difficulty about that, as it was possible to do almost anything with electricity. Pending the solution of this engineering enigma it is understood that the work of construction, which had hitherto been going on briskly, has been temporarily suspended.

THE supreme court of Massachusetts has decided, in an action brought by a hackman to recover damages for injuries sustained by the falling of an insulator from an overhead trolley-wire, that the railway company was guilty of negligence in not making its structure strong enough for the strain to which it was necessarily subjected when in use. The mutual rights and duties of the drivers of vehicles and of electric cars have also been defined, by another decision of the same court, in a case in which a horse was frightened by the gong of a car some distance away, notwithstanding which the motorman continued

to sound his alarm, resulting in the flight of the horse and a serious accident to the occupants of the vehicle. The court held that the rights of the two parties in the street were equal, and that each was bound to use it with a reasonable regard for the safety and convenience of the other, and hence that it was the duty of the motorman to look out that he was not unnecessarily frightening horses, or putting in peril other persons lawfully using the street, either on foot or with vehicles.

THE American Bell Telephone Co. has paid in dividends, from 1880 to 1893 inclusive, a total of $23,100,000, being an average per year of $1,750,435, on an average capitalization during the same period of $11,209,035. The fundamental patents on the telephone are now public property, the last one having expired on January 30 of the present year. The company still holds many unexpired patents of value covering subsidiary inventions relating, for the most part, to long-distance transmission and to apparatus for facilitating exchange operations.

ALTHOUGH there has been no legislation in Massachusetts compelling electrical companies to place their wires underground, the returns for 1893 show that in respect to the comparative length of telephone wires in subterranean conduits Boston is among the foremost cities of the world. The total length of underground telephone conductors now in operation in that city is no less than 8250 miles. The work in that city was commenced as far back as 1881, but it is worthy of note that all the cables which were in use up to six years ago have been removed and replaced by new ones having a largely-increased capacity for conveying telephonic currents. The new cables are composed of copper wires, insulated with paper or fiber. They are twisted together in pairs, after which the pairs are laid up in reverse spirals to neutralize induction, and the whole covered with an impervious sheath of lead containing an admixture of a small proportion of tin, which alloy has been found to resist decay much better than pure lead. The work of placing the telephone wires underground is now going forward in a number of other Massachusetts cities. A comparison of percentages shows that in London practically the whole telephone-exchange system is overhead, being carried over the housetops, while in Berlin only 52 per cent. of the entire mileage is underground, as against 80 per cent. in the old part of Boston. The proportion of underground wire in New York is nearly as great as in Boston.

THE new power-station which has just been built for the Brooklyn City Railroad Co., at the corner of Kent and Division avenues, is a notable piece of work. The building is on the water-front and covers an area of 255x205 feet. There are 18 pairs of boilers, rated at 500 horse-power per pair, and six horizontal cross-compound engines, having cylinders of 32 and and 62 inches diameter and 60 inches stroke, rated at 2000 horse-power each. Each engine is coupled directly to a 1500 kilowatts twelve-pole generator, and the six combined machines are arranged in two rows of three,—one on each side of the engine-room. The stack is 292 feet high and weighs about 3000 tons. Everything about the station is fireproof, and the greatest precautions have been taken to avoid any possible necessity of shutting down in consequence of an accident to any portion of the machinery or equipment. The capacity of the plant is sufficient to operate something like 2000 cars at once.

ONE of the largest electric plants now operated by water-power is that of the aluminum company at Neuhausen, Switzland. There are eight turbines of the Jonval type, of 600 horse-power each, running at 150 revolutions per minute, and one of 300 horse-power running at 250 revolutions per minute. The water is admitted from below, and thus the pressure serves to balance and carry the weight of the wheels. Each turbine has a 24-pole generator coupled directly to it, the output of which is used in the electric smelting furnace. The capacity of the plant is about 5500 pounds of aluminum per day.

ARCHITECTURE

Conducted by Barr Ferree.

THE yearly exhibition of the Architectural League of New York is considered by many—and especially by the League itself—the architectural event of the time. Certainly it is the most numerous collection of architectural drawings to be seen at any time in America, and while it is nominally a local exhibition, and was never more so than this year, it is entitled to respectful consideration, though it may not be possible always to develop enthusiasm for it. But the exhibition this year, which recently closed, was a really notable one. It was by far the largest in point of numbers that the League has yet had, the total number of entries in the catalogue reaching 809, with many unnumbered exhibits. A good many of these referred to objects not architectural, but, under the heading of allied and decorative arts, included a miscellaneous collection of objects, from cartoons for frescoes and stained-glass windows to embroideries and pieces of iron-work. It seems a pity that the League should burden its exhibition with objects of this description. Interesting and valuable as many of them are, they help nevertheless to divert public attention from the more serious purpose of the exhibition, which is architecture. This condition was further complicated this year by the joint-exhibition of the Sculpture Society, which tended to reduce architecture to an almost subordinate position in its own exhibition. So long as architecture itself maintains the dominating position no objection can be taken to the inclusion of other phases of art, especially if they actually serve their nominal purpose of attracting the "public." There is no subject on which that great and mighty body needs instruction and light more than it does on architecture, and if the League succeeds in giving this it will have accomplished a greater end, have achieved a more magnificent triumph, and be entitled to a greater reward, than any contemporary artistic body.

BUT there is not the slightest ground for supposing that this result will be achieved from the recent exhibition or from any other conducted on the same basis. On the contrary, one rather looked for an unarchitectural show among so much that did not belong to architecture. And one was not disappointed. In the first place, there was an unusually small number of architectural drawings in the collection. Water-colors there were galore, and most astonishing water-colors many of them were. These were pretty pictures intended to catch the public's eye, without any save a pictorial value, and affording no contribution to architectural knowledge or illustration. Huge office-buildings, immense hotels, vast country-seats—embellished with whole mountains in the background—city dwellings and country houses, details and views of cities were all shown in the medium of water-color. The walls of the gallery blazed with colors quite as brilliant as one would wish to see in a collection of paintings. Even the worst of these,—and there were many such,—represented a great expenditure of money that had better have been spent in preparing drawings of architectural interest and value. There is no sense whatever in making a water-color of a sixteen-story office-building, and while the trustees of a hospital or of a museum might require a water-color drawing to attract interest to their work, there is no reason why every sort of building under all circumstances should be illustrated in this medium. First of all, therefore, the exhibition began with being unarchitectural. It well seconded this extraordinary posi-

tion by the lack of plans. Though plans were few in number, the average was a good deal higher than at any previous exhibition. We counted thirty plans attached to drawings in the Vanderbilt gallery, in which most of the architectural drawings were placed. It is true that many of these were small and of little value, but, considering the place and the circumstance, no great fault can be found with this number. There might well have been many more, and certainly there was great need of a plan to illustrate the water-color of the new building for the Brooklyn Museum of Arts and Sciences, shown by McKim, Mead & White. For an institution of so high-sounding a title to put out a "picture" of its new building with the idea that people might study it, indicates a most deplorable conception of what is right.

THOSE of our readers who are of an historical turn of mind may recall some paragraphs in this Department, about a year ago, anent architectural competitions and the juries who undertook to decide them. Incidentally, we pointed out a tendency of this work to fall into the hands of the professors in the architectural schools and submitted some reasons why these worthy gentlemen were not always desirable for such work. In itself this was a point of no great consequence, but it helped to enforce what we had intended to be the special lesson to be deduced from our remarks, namely, that the judgment of many architectural competitions by the same authority was detrimental to the progress of architecture. What is the first thing the competing architect thinks of when he composes his mind to thoughts for a competition design? The judge. The criminal in the prison entertains no more wholesome fear or distrust of his judge than the competing architect of the gentleman or gentlemen on whose decision will depend the obtaining of the work desired. The idea of a competent opinion on the drawing as a work of architecture is quite lost sight of in the scramble for the work and the commission it will bring. Everything rests on the judge,—or the jury, if a plural form is preferred. His tastes, his inclination, his judgments in other competitions are carefully reviewed, considered, and digested. The design is forthwith begun with all this well in view. The style is the judge's style, the form is his, the detail, —the plan, if possible. It may be a style that the architect is himself unfamiliar with, it may be unsuited to the type of structure—a most important fact that few people appear to have grasped as yet—it may be bad in itself. But it is the judge's, and that is all that is needed. It seems scarcely necessary to point out how stifling this is to progressive art, how it is binding current work within bands of iron, keeping down original thought, insisting on a common standard for all things, unifying architecture as it never was unified before. And so while the sentimentalists and very young men are telling us that competitions are providing opportunities for slumbering geniuses, opening the way to those who otherwise would knock unheard at the gates of fame, it is nevertheless a fact that competitions are slowly drawing the life-blood out of current architecture; they are stupefying progress and putting a premium on pampering the ideas of an external party.

WE are living in a veritable age of competitions. On every side programs are issuing from the press and the typewriter, or they may not be proposed at all, the architect being left to his own devices. Closed and open competitions are now proposed for almost every type of structure under the sun, and a jury or committee appointed to pass on their respective merits. It is a well-established principle in law, we believe, that no man shall occupy the judicial bench who is not a lawyer and who has not proved his fitness by practice and study. It would seem to be only in accordance with the dictates of common sense to require the same knowledge, the same proof of fitness, in the architectural judge. A competition for a thirty-story office-building is proposed; yet who is capable of rendering a decision? Who has ever built a thirty-story office-building, or even given the

smallest hint that he understood how it should be treated and what it should signify? One does not need to have built a building in order to judge its architectural merit, but one surely needs to give some indication that he understands the problem to be worked out. And unless there is a competent judge there can be no successful competition. While this much certainly is clear, yet day after day the same people run the risk of being chosen to judge competitions, with the chief result that the buildings erected correspond to their own individual ideas of what is good. Continue the process long enough and the future historian of American architecture will be able to trace certain distinctive periods in our work which may be called the "Jones period" or the "Smith period,"—not because Jones or Smith devised a style of his own which had a more or less certain vogue, but because they influenced the taste of their time by sitting in judgment in competitions. This is a pretty howdy-do, and something quite new to boot. It remains entirely with the architects whether they will permit such a state of things or not. They have only to form an Anti-Competition League and stay out of competitions, and the whole of the great artificial fabric that is being reared with their help falls to the ground. The continuance of the system rests wholly with them. The dissatisfaction with it that we find prevalent among the professional should take visible form in some such manner as here suggested. Sooner or later the retarding effect of competitions will be recognized, and the sooner the better.

FEW questions are so interesting and important to the young architect as the method of advancing himself in his profession. An architect's light somewhat necessarily shines under a bushel; a very important point with him is emergence to a hill-top, where it may be seen of all men. Various ways are tried to the obtaining of this end. The blowing of one's trumpet is one way, and logically rests on the proposition that if one does not blow one's own trumpet no one else will. There is a world of truth in this which every one must appreciate. The difficulty seems to be in determining the manner in which the trumpet shall be blown. The perpetual propulsion of air through this instrument is apt to become wearisome after a time and quite fail of its end; for obnoxious trumpet-blowing is worse than none at all. It seems to be an art that requires the utmost care, and is not to be commended for general practice. Then there is what may be termed the faddic method, in which the interest of a so-called critic is enlisted and public sympathy aroused in this manner. Examples of the successful workings of this system are too well known to be enumerated here. It implies a dishonesty of purpose and a personal interest that destroys the value of architectural criticism and renders those benefited by it objects of suspicion by those who cannot boast a critic among their individual possessions. As for the critic, his (or her) position is very much like that of the court-jesters of ancient history,—the personal property of their lord and master, without any special individual right for existence. Then there is the public method, interviews in the press, published drawings, and the like—a sort of combination of the previously-described methods. The professional journals are likewise made use of to a certain extent, but who looks into the professional journals save the professionals themselves, and others interested in architecture but who are not giving out work? The competitive method has lately come into use, but even this is balked by the provision inserted in every well-drawn program, that a competent architect shall be associated with the winner if he be deemed unsuitable, on account of age or inexperience, to perform the work himself. No one profits by such competitions, and, incidentally, no one but a skilled practitioner is likely to be successful in the average competition. It is a great problem; can any one help in its solution?

IT is quite to be expected that the architecture of the World's Columbian Exposition will be echoed and reëchoed for many years to come, and especially in the public

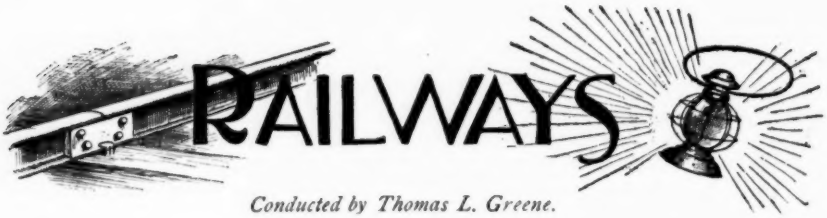
buildings of this country. American architects are prone to use the material most closely at their hands without regard to its suitability to the special purpose they may be working upon. The Fair buildings being temporary structures, their forms and ideals may safely be copied without reproducing actual structures. The authors of the Agricultural building have themselves set a notable example in this respect in their design for the Brooklyn Institute Museum, which is a frank development of their Chicago building. Others will doubtless follow suit and we shall probably see much of the Fair for years to come. Apart from the Brooklyn example the most noticeable effect yet manifested was seen in the competition for the Public Library and Museum at Milwaukee. This was a public competition and the opportunity it offered to architects to distinguish themselves was availed of by about seventy. As was to be expected, all sorts of designs, good, bad, and indifferent, were sent in, but the most striking feature of the collection was the reproduction of motifs from the Fair buildings. Not that the buildings were reproduced *in toto*, but the domes of the Agricultural Hall and the Palace of the Fine Arts had several reproductions, the towers of Machinery Hall come in for their share, and sundry other ideas were copied and embodied in the competitive designs. Such reproductions are just what might have been looked for, and this competition is probably only the first of a series in which the same duplication will be noted. It cannot be said that the additions thus made to the vocabulary—if so it may be called—of American architects is a useful one. An architectural form is something not to be copied but to be developed. The mere placing of a dome on top of a building implies no competency on the part of the architect if he has not placed it well, nor does the borrowing of a tower, simply because it is borrowed, express anything. The designs in the Milwaukee competition, apart from this incorporating of new motifs, were not, as a whole, good. They ran from Renaissance to Romanesque, with the perhaps not unexpected result that the Romanesque designs were quieter, more sedate, more stately, and apparently more suitable than the more ornate productions of the Renaissance, even with or without the example of the Fair buildings. The design finally chosen was Renaissance.

FROM time to time we have made it our business to point out some of the manifest and general excellencies of commercial architecture in Chicago. We have not hesitated to point out that some of it was very bad, but on an average it is superior to the commercial architecture of New York because a good deal of it illustrates an honest, manful attempt to make a building, while the prevailing note of New York commercial architecture is to make a façade, to use up the space in the best possible way, and to be satisfied if ideas hold out until the top is reached. In some instances the commercial architecture of Chicago rises to the very highest point of the artistic, so far as a commercial building can be artistic, which may be seen in the Schiller Theater, to speak directly and to the point, Were this an age of progressive architecture an artistic building like the Schiller would be seized upon by every designer of a high building and the progress attained in that used as the basis for further progress and study. Alas! this is not a progressive age in architecture, though never did an age stand in greater need of progress. We do things in this day pretty much as we please, without regard to what other people did and how they did it. In a measure this is sound doctrine, and especially so in relation with the high building, which is something entirely new under the sun. But because the high building is new it does not imply that every designer should seek to solve it upon his own hook, without regard to what others are doing. The sensible way is to find out what progress has been made and use that in further steps of progress.

ALL this is naturally introductory to the dirge we are about to sing over Chicago architecture, for the progress indicated so brilliantly a couple of years ago has since been departed from in a most unfortunate

manner. In writing of Chicago architecture it is no longer possible to speak only of its strong good points, but a good-sized chapter must be devoted to its evil aspects, which, in some respects, quite outdo the horrors of New York commercial architecture in its worst phase. And this all comes from the fact that while the number of architects in Chicago who have given any evidence of actually comprehending the high problem can be counted on the fingers of one hand, all the architects of that most bustling town are convinced not only that they do understand it, but that nobody else does. So we have served up to us a monstrosity like the Columbus Memorial Building, to which we invited the attention of our readers last month,—a quite idealless structure that should have been impossible both of thought and of erection. And so, in a very different way, but nevertheless surely and unmistakably indicative of downward progress, is the new Marshall Field & Co. building. This is a large and dignified building, nine stories in height, situated on a corner lot. It is quite devoid of the eccentricities which made the Columbus building so absurd, but it shows that its author has forgotten how to design a high building, for he has previously done most excellent work that exhibited a full understanding of the problem. Yet as a matter of fact everything is good about this building but the idea and the form. The detail is sufficently well done, the windows and parts are well proportioned, the entire work is dignified and stately; yet it has the crowning misfortune of lacking homogeneity. Horizontal lines, not vertical ones, are the leading elements of the design, and when this is the case with a nine-story building one of the prime essentials—unity—of a high building has been ignored. The basement is two stories, capped with a cornice. Then comes a single story with a cornice over it,—neither basement nor superstructure, but somewhat like Mohammed's coffin, suspended midway between the two. The superstructure proper may be supposed to begin above this story and is three stories high. Its leading motif is a triple bay with round arches in the center of each façade. Over this portion comes a cornice, introduced, apparently, for no other reason than to serve as an excuse for starting a series of two-story bays extending wholly around the building and carrying small round arches one window wide. Then comes a cornice and a frieze-story sufficiently satisfactory in itself, then a broad stately cornice most appropriately crowning the structure, and over this a balustrade that closes the building. There is so much that is good in this front that it seems a pity there should be any bad in it. Yet the bad is badness of idea, not of execution, and when the idea is bad an evil result is not far off.

A NUMBER of large and costly catalogues which have come to our table recently deserve more than a passing notice. The activity with which manufacturers place their goods upon the market naturally results in their putting forth more elaborate descriptions and illustrative matter of new goods and most recent devices than will be found in the current periodical publications of the day, whose business is nominally bringing these things before the attention of consumers. And surely it would be difficult for any manufacturer to issue a more splendid illustration of his products than the sumptuous catalogue recently issued by the Standard Manufacturing Co., of Pittsburgh, illustrative of their bath-tubs, water-closets, and fittings. Superbly gotten up as this book is, the catalogue of the Meyer–Sniffen Co., Limited, of New York, is not second to it, either in elaborateness of detail or in gorgeousness of attire. The goods described and illustrated with most abundant illustration are bath-tubs, plumbing apparatus, water-closets, and the like. Very much the same may be said of the catalogues of the J. L. Mott Iron Works, of New York and Chicago. They send us several richly-illustrated catalogues of sanitary apparatus, tubs, stable-fixings, tiles, and the like, all illustrated in the finest manner. Quite as interesting in its way is the catalogue of the Pierce, Butler & Pierce Manufacturing Co., of Syracuse, N. Y., covering the fields of heating and plumbing supplies.



Conducted by Thomas L. Greene.

THE prevailing business depression is leading the railways to practise economy in every direction. Employés are laid off and in many cases wages are reduced also. Retrenchment in the amount of new construction, repairs, and renewals is equivalent in many instances to an abandonment of all that kind of work. The result is severely felt in many important lines of trade which have depended largely upon the railway demand for a market. All feel the loss of trade in greater or less degree; but while business is dull everywhere, the stoppage of all repairs and renewals brings the trade of certain lines to a complete standstill.

Very likely the position of the railway manager has not received the consideration it deserves. That manager is employed by the owners of the property to operate it for their benefit. Usually a heavy mortgage has to be taken into account whose interest day cannot be passed without the required payments from money accumulating, perhaps, for months; or a failure to declare a dividend would bring discredit and perhaps dismissal, particularly if the company has a long record of such yearly returns to the shareholders. With the necessity for the accumulation of this money staring him in the face, the railway manager retrenches where an immediate saving can be effected. Trade-unionism has made it not so easy to reduce wages, and even if the case is desperate earnings will provide for train expenses. So the easiest thing to do is to stop repairs of equipment, the purchase of rails and ties, or of tools or of the smaller things like lanterns; as the supply on hand diminishes no more is bought; or if purchases are made the seller is told that his bill is "vouchered" for payment when the company has funds.

The custom of handling a railway's surplus earnings makes this course apparently easy. While among manufacturers a certain amount in cash is yearly set aside for depreciation, among carriers the rule is to renew old cars and engines or parts of the track and roadbed yearly, as the same requires it. Thus the sum which the factory accumulates, and which perhaps is spent in one large amount for new machinery, is by the railway method expended annually for a proportionate amount of work. In a time of stress it is easy for a while to check the expenditures for these renewals; nor can it be said that the result is in every case at once disastrous. If a railway has set its face against the English method of paying out all surplus earnings to its shareholders, and has in prosperous times spent liberal sums upon its property, then it can cut down the sums to be expended upon the plant for a year with the knowledge that its good condition will prevent serious harm resulting. Yet even in that case this process of "starving" the property is poor economy. Under the best of circumstances for every dollar thus saved there must be spent two or three dollars when the neglect comes to be made up. Railway-men know this well, but the necessity for the immediate dollar leads them to hope to earn the additional dollars when times become better.

THE case so far presented assumes that equipment and track are in the best condition. The majority of roads are not so fortunately situated. The business depression has caught many lines unprepared for a strain of severe economies very long continued; in those instances lack of repairs may imperil the safety of trains and consequently of passengers and employés; such lack certainly means high cost of

operating. In such cases, too, the bondholders or stockholders for the sake of one or two interest or dividend payments are really staking their whole principal. At the end such uneconomical savings will necessitate the spending of large sums upon the property to fit it for its business of transportation, and to effect this a reorganization may then be necessary, involving heavy losses upon all concerned. It would be far better financially, as well as more honorable, if our railway policy allowed a different course. Certain reductions in the sums allotted to renewals are proper in times of depression, but when that depression is long continued, or when a company is not well prepared to stand the strain of such heroic remedies, the best course is for the manager of that company to face the situation. He should explain publicly that certain repairs and other expenditures are a necessity if the road is to be kept running; that the earnings do not at the time warrant such expenditures if returns to capital be continued, but that it would be for the real advantage of the bondholder or stockholder to forego one or two interest or dividend payments to the end that his investment may be finally secured to him. No manager would like to be alone in making such an announcement, and it unquestionably would require moral courage of a high order, yet the public opinion of all concerned,—travelers, shippers, and investors,—ought to sustain such a course as wise and honorable. A plant already in poor condition ought not to bear a further strain because the board of directors think themselves obliged to gamble on future prosperity, with the known odds greatly against them.

BUT receipts in normal years ought to be large enough to cover such expenses as are specified above. Close observers of the times think they see much danger ahead for railway capital unless conditions change. It is a fact much to be regretted that transportation does not "pay"; that is, the revenues received by the rail carriers are insufficient to meet the proper expenses of renewals and of the better and safer train service now demanded and to leave over a surplus sufficient for a reasonable return on the capital invested. Increases in wages account for this unfortunate fact in part, but the real explanation lies in the gradual but steady decline in the rates received. A decrease in tonnage is indeed usually accompanied by a reduction in tariffs; but beyond all that it is clear that the general average of railway charges is too low. An idea prevailed among the public before the passage of the interstate commerce law that railways were fair game; that reductions in rates were good for the farmers and hurt nobody. We know better now; but meanwhile it was in something of this spirit that the act to regulate commerce was passed. It was not an equitable law, but was enacted in hostility to the carriers. The commissioners so interpreted it, for in one of their early decisions it was held in substance that no power was granted that body to put up rates, no matter how they had been forced down. The question of "unreasonableness" in the act referred to high, not to low, tariffs. The railways play so large a part in our commercial world that when they are cutting wages, discharging men, and postponing inevitable repairs, every one feels it. The annual report of the interstate commerce commission bears directly upon this part of our railway problem.

IT is much to their credit that the commissioners ask for authority to prescribe minimum as well as maximum rates. It signifies that rates may be forced by competition too low for the public good. But why should rates be too low? Partly of course through the fault of the railways themselves, but largely through the effect of this same law which the commission asks to have amended. Why not strike out the faulty clauses of the law rather than try to help things by amending them? As we have just said, the general spirit of the law is hostile to the carriers, but two sections of the act are especially so. These are the sections prohibiting pooling and the one forbidding a larger charge for a shorter haul in all cases.

TO a certain extent the evil effects of

these two sections run together, though they may be discussed separately. The intent of the act to regulate commerce is to prevent, not discrimination, but unjust discrimination. Discrimination—the art of seeing essential differences between things—is as much a necessity in transportation as in trade. The law was not intended to stop the carriers from charging higher rates upon silks than upon wheat, for instance, though that is discrimination. Whether discrimination is just or unjust depends upon the circumstances of each case, whether the difference in charge corresponds to a well-founded difference in the trade or in the nature of commercial things. Hence it follows that no hard and fast rule can be laid down about this matter of difference of charge without working injury to the railways and, through them, to the community. Now the fundamental objection to the short-haul prohibition is that it decides beforehand and in all cases that a discrimination between places is unjust. There are instances when a higher charge to a local town is clearly inequitable, and there are also instances when it is not unfair; but all are alike condemned under the law as it stands without a hearing, the commission having refused to accept the unbusinesslike proposal of the act and give permission for its violation before the actual putting in force of the disputed rates. In considering complaints of short-haul infractions brought before it, the commission has naturally and logically been guided by the hostile spirit of the law in leaning toward the shippers who were charged what they considered too high rates. But in the few cases in which these decisions of the commission have been passed upon by the courts, we find the judges almost universally holding the commission's opinion to have been inequitable. The case of the city of San Bernardino, California, is an example. Rates from the east to this point were higher than to places on the Pacific coast; the commission ordered them reduced, but the judge denied the asked-for legal relief, holding the commission's action not warranted.

AN inland case of the same general tenor is that of Social Circle, a local station on the Georgia railroad between Atlanta and Augusta. Carriages from Cincinnati were charged more to the little town than to Augusta. There was a through rate from Cincinnati to Augusta low enough to meet seaboard competition, while the railroad demanded its local rates from Atlanta to Social Circle, refusing through tariffs from Cincinnati. The commission held that the aggregate of charges from Cincinnati to Social Circle, no matter how made up, must be less than the through charges to Augusta; but the United States court decided against that contention. Another late decision, by putting a fine definition upon the meaning of the word "line," has partly nullified the severity of the law. Without impugning the motives of the well-known jurist who made this decision, we may believe that he was led to that opinion by the clearly inequitable working of that section against the carrier.

THE plain fact of the matter is that where a higher charge is made for a shorter distance the case should be examined on its merits. If the whole section were struck from the law, the question of rightfulness could still be brought up before the commission under the other sections forbidding unjust discrimination, with the very important difference that then the dispute would not, as now, be prejudged against the carrier. There is force in the contention of General E. P. Alexander and others that a railway is justified in relying primarily upon its local traffic. If it gets through shipments at a lower proportionate rate, those traffics generally pay something into the treasury and so enable the company to reduce its local charges. It is the duty,—and, we may add, the best policy,—of the railway gradually to quote lower and lower local rates as the general prosperity of the company increases from all its business, until the towns along its line are placed upon an equality with the great cities in selling their produce in the large markets or in bidding for factories. The dispute between the company and its local shippers generally concerns the rapid-

ity with which these reductions may properly be demanded; and this question is a fair one to be referred to an arbitrating body of some kind. For a railway, if very prosperous, is inclined to pay higher dividends rather than reduce rates; hence the fair rule would be to share the larger profits between the stockholders and the local shippers.

THE far-reaching effects of the universal arrangements of tariffs on the basis of a lower charge for a shorter distance are not easily traced in detail, but railway-men believe that to federal and State legislation is due no small share of the responsibility for the insolvency of so many of our leading companies. Judge Dillon records it as his opinion that the troubles of the Union Pacific are due partly to this very cause. The heavy capitalization of that system makes it imperative that earnings should reach a large sum. But its receipts from transcontinental (*i. e.*, Pacific coast) traffic are limited by ocean competition, which lately has been very severe. Its competitors at other and inland points are active. The Union Pacific must thus accept what it can get on much of its tonnage, but cannot fill its declining treasury from its other traffic. Thus we have the curious spectacle of a nation which is a large creditor of a large corporation seeking to imperil its own security by limiting the charges, and therefore the profits of the debtor, upon which it must depend for ultimate payment.

THE local demand for rates as low as the through charges arises partly from the decline in the average through rates, with which the local rates are always being compared. This decline in through charges has been hastened by the interstate act, which forbids pooling. Before 1887 it was customary for the railways to agree upon rates and upon the proportion of the competitive tonnage which each company should carry. In one or two cases,—the roads between Chicago and the Missouri-river cities are examples,—these pools held rates so high as to induce the building of competing railways beyond the needs of the country, and thus brought about their own punishment. But in the majority of cases these railway pools held together only so long as the rates and proportions were commercially equitable; for these pools were mere agreements, non-enforceable in the courts and dependent upon their inherent fairness for their support. Their great merit was that they brought up for discussion in the light of day and put in a way of settlement those disputes which are always arising between rivals having large interests, and which now result in the "cutting" of rates. A "cut" rate is usually an offer of transportation at a price lower than is warranted by the commercial conditions. It is a rate not decided upon on scientific principles or on any ground of reason whatever, but because some rival is supposed by some trick to be getting a better share of the general traffic,—a very poor basis for a change involving, if carried far enough, profits or losses to those engaged in trade and serious results to employés, supply-merchants, and shareholders alike. In what other line of business do we use such rule-of-thumb methods in dealing with grave issues? It is further to be remarked that the prohibition of (unenforceable) pooling or of reasonable agreements among carriers takes from the railways a trade privilege which business men in other lines are not forbidden to use. We do not, for example, prohibit paint-manufacturers from organizing. We know that such agreements cannot be enforced. We know, too, that the prices of paint cannot be sustained at exorbitant figures by verbal or illegal contracts or understandings; therefore we rest content. The action of commercial laws is slower among railways than among paint-dealers, by reason of the largeness of the business of transportation; but the end is as sure in one case as in the other. Among railways, as among merchants, the effect of a trade union in actual practice is to prevent losses,—not to get unjust profits, which indeed are not long possible in either case.

THE one argument relied upon in favor of the prohibition of pooling is that the railways, if left to themselves, would in-

stantly put up rates to an exorbitant figure over the whole country. For the sake of a brief discussion on this point we will assume that the companies have banded themselves together to act as a unit on the rate question, with power to enforce their decisions. We know that the assumed condition is impossible, but we will take the extreme supposition. It is not realized by everybody how little real power over rates rests with the traffic-managers; their actual duties are not to originate tariffs, but to register in their tariffs the existing commercial conditions. The Pacific roads, we may be sure, did not of their own free will put in force a rate of $1 per 100 pounds for the carriage of California products from that State, 3300 miles to the Atlantic seaboard. The market price of a manufactured article at Chicago is fixed by the competitive sales of that article made, let us say, in Alabama, Pennsylvania, Massachusetts, and in Chicago itself. This selling-price, after deducting the cost at the factory, leaves a margin of profit which must be shared between the manufacturer and the carrier. If the railway should charge the whole of this profit for transportation the traffic would cease. In such a case the railway would get nothing. "Enlightened selfishness" must always prevent the railways from establishing such rates as would leave nothing for the shipper; such a policy would ruin their own business. The whole commercial market of the United States is established on a low average charge for transportation. The companies could not greatly alter those charges without involving themselves in bankruptcy. Extortionate tariffs on our railways are, therefore, commercially impossible. Such tariffs are impossible also because of our great waterways, lakes, rivers, and canals, which limit rail charges directly and indirectly to a degree not suspected by the ordinary man. We may therefore consider that the railways are not to be feared even when under a pool, and that even if firmly bound together (conceding this to be possible) they could not practise extortion without ruining themselves and their owners. As things are now, the railways need protection against unjustly low rates much more than their patrons against unjustly high ones. And if so great an interest as that of transportation is not allowed reasonable prosperity, every member of the business body will suffer too.

In this connection should be briefly noticed the contention of the commission that the short-haul section "is nothing but an extension to places of the rule forbidding unjust discrimination between persons." The absurdity of this contention is seen clearly in the light of what has been already said. Discrimination between an occasional traveler and a commuter is regarded as equitable, while no discrimination, fair or unfair, is allowable under that famous section. Again, the commission says that no "railway insolvency can justly be attributed to the operation of the law," and then adds, "the law can operate to limit railway revenue only by preventing unjust charges and undue partiality," which merely begs the question at issue. If a railway goes into receivers' hands it is evidence that its charges were unjust! If every reduction is *ipso facto* a prevention of some injustice, why ask for the right to prescribe minimum rates against excessive competition? Such quibbling should have no place in a public report.

The denunciation of the system of overcharges is emphatic and true. It is a scandal to our railways that, when a palpable error in the computation of charges has been made, a consignee cannot get his property without paying the whole amount asked for, trusting to receive back the overcharge upon presentation of a claim. The companies have had their attention called to the evil many times, but as yet have taken no real steps toward a remedy. Of course it often happens that the delivering road did not make the mistake, but that an intermediary company collected the excess amount and yet holds it. But if those companies could unite in the establishment of through shipments at agreed rates and proportions, they can also consent to the correction of these irritating

overcharges at destination at the expense of the member of the line which has retained the money not belonging to it. It is a source of wonder that the mercantile community has borne this gross abuse so long and so patiently. It is time that overcharges, when clearly shown to be errors, should be corrected on demand.

THE announcement of the opening of the great Manchester canal in England and the recent trial of electricity as a motive power on the Erie canal call attention to the question of competition between railways and water-routes. It is an ever present question in the United States because of the natural water-courses. The great lakes and the rivers are always factors in our general rate problems. Mr. Albert Fink's argument showing how the Erie canal affected all inland charges will be remembered. It is sometimes said that the competition has grown dull because the Mississippi river—for example—carries comparatively little commerce. This assumption is erroneous. If grain from Nebraska could reach Europe via that river at a cheaper charge than via the Atlantic seaboard, the grain would be carried through the Mississippi. Nor need any large quantity be so moved in order to affect the rate problem: a little increase would demonstrate the fact of such cheapness, and the mere potentiality would be enough to compel a readjustment of trunk-line tariffs.

Experience demonstrates that a waterway is in the long run no injury to a railway. At first of course it may take some traffic away from the rail carrier, but the cheapness of transportation for the raw materials builds up the city so favored, the railway participating in the prosperity and carrying such a quantity of higher-priced traffic as to more than make up the original loss. The Erie canal has always limited the charges of the New York Central, yet that same road is the envy of its neighbors because of the populous and prospering towns which fill the Hudson and Mohawk valleys. It may be set down as a transportation axiom that anything which benefits a section of the country benefits the carriers also. It is believed by some that the opening of the Nicaragua canal would injure the so-called transcontinental roads. Perhaps so, but if so for a short time only. Any increase in the business of the Pacific coast would be certain in the end to increase the railway traffic as well.

ONE of the troubles of the railways is indicated by some figures on the profits of wheat-growers compiled from the reports of the statistician of the Department of Agriculture. In 1891 we had the unusual combination of a large crop and good prices. In that year the average yield per acre in Minnesota and North Dakota and the average price at the farm gave the wheat farmers of those States upwards of $15 per acre. Careful computations by details put the cost of wheat-growing at $6 per acre, including $1 for use of the land. The great profits of 1891 are therefore apparent. The farmers were very prosperous: they paid off mortgages, rebuilt their houses, and bought pianos, so that all the merchants in their territory had a good trade. The receipts per acre in 1892 were but little more than half those of 1891. But the prosperity of the previous year extended through 1891 also. In 1893, on the contrary, the conditions were reversed: we had a low average yield and a price at the farms as low as 43 cents per bushel; a combination which gave to the wheat-producers less than $5 per acre on the average,—not enough to pay expenses. The last of the great profits of 1891 were consumed in making both ends meet in 1893. The comparatively small yield and the low prices have left the farmers of the northwest without purchasing power. Until there are better crops or better prices the railways must look for a small tonnage, both for grain out and supplies in. The same thing is true of the winter-wheat States. The wheat-producers cannot for a while support the railways with large shipments either eastward or westward, except for immediate necessities. But as merchants report stocks of goods as small in interior towns, the revival, when it comes, will be accompanied, it is believed, by increased freights.

CIVIL ENGINEERING.

Conducted by John C. Trautwine, Jr.

THE fall, on December 15, of the single-track railway bridge which was being thrown across the Ohio river between Louisville, Kentucky, and the opposite town of Jeffersonville, Indiana, was one of the most serious catastrophes of recent years. The bridge was being constructed by the Phœnix Bridge Co.,—J. Sterling Deans, chief engineer. Of its three channel spans, each of about 550 feet, one was practically complete, the false work having been removed, the second was in place with the exception of one or two panels at the south end, with the false work still under it, while the false work for the third span was just being put in place. The spans weigh about 2,000,000 pounds each. It had been noticed that the traveler swayed somewhat under high winds, and steps were being taken to strengthen it, but while this was being done the false work under it gave way and the structure was hurled into the river, carrying some fifty men with it. A few minutes later the portion of false work in place in the next span fell as a consequence of the destruction of that in the first span. In the evening, the nearly finished span, from which the false work had been removed, fell into the river, entailing, of course, enormous loss, but fortunately without further loss of life. After the fall of the first span it was found that seventeen men were standing on the pier at its end. These men, with the greatest coolness and presence of mind, at once took measures to save the portion of false work in the next span, but their efforts proved unavailing.

The cause of the accident seems to be, as the newspapers would say, shrouded in mystery. Mr. Deans, the engineer for the contractors, claims that the bridge was thrown down by wind of cyclonic force. The records of the weather bureau in Louisville, however, show thirty-six miles per hour as the maximum wind velocity on the day of the accident, a velocity far too slight to account for such an accident if all was as it should be. It might not unreasonably be supposed that the valley of the river formed the path of a wind of much greater velocity than that recorded at the office of the weather bureau, but opposed to this view is the fact that the woods on Towhead island, close to the site of the bridge, afterwards showed no signs of extraordinary wind action. It might, of course, very well be that the wind came in puffs at intervals corresponding to the period of vibration of the traveler or of the truss. Certainly, such very tall single-track bridges,—some 92 feet high by 30 feet wide,—offer a serious temptation to an ill-disposed gust, even after everything is in place. The history of the building of this bridge has been a sad one. Some three or four years ago there were two serious accidents with the foundation caissons, in one of which several men were drowned.

IN designing the superstructure of the great cantilever bridge with which it is proposed to cross the Channel between England and France, where the spans between piers will be 400 and 500 meters (1313 and 1640 feet) respectively, with 65 meters or 213 feet for the maximum depth of trusses, Messrs. Schneider et Cie., of Creusot, have proposed for the deeper portions an arrangement of the trusses so as to give to the bridge a triangular cross-section. In other words, the two trusses will be inclined inward until their top chords meet. The base of the triangle thus formed will be 25 meters, or 81 feet. Within this triangular tube the rails (double track) will be carried by a most formidable structure of trapezoidal form, the base and sides of which will be formed

of lattice columns, the lower apices of the trapezoid being framed to the lower chords of the trusses.

The triangular disposition of the trusses offers an extremely simple and rational method of bracing against lateral wind pressure. It is of course applicable only where the depth of the trusses is such as to give sufficient head-room. Towards the ends of the parabolic cantilevers, where the head-room becomes insufficient for a triangular arrangement, the cross section assumes the usual rectangular form. The independent bridges of 125 meters, or 410 feet, span, supported between the ends of the cantilevers, are of rectangular cross section throughout.

In the designs for this greatest of all bridges, as exhibited at Paris in 1889, it was estimated that a million tons of material would be used, that ten years would be occupied in the construction, and that the cost would reach $172,000,000, more than half of which would be required by the superstructure. The line was to cross from Folkestone, on the English side, to a point about a mile south of Cape Griz Nez, on the French side, and about two miles northwest of the town of Ambleteuse, the port of which was to be considerably developed in connection with the bridge operations.

The line of the bridge, which joined the Southeastern railway of England with the Northern railway of France, deflected from a straight line in order to utilize the shoals of Le Verne and Le Colbart, which lie some two or three miles to the south of a line joining the two extremities of the bridge. At each of these points a short curve was introduced, and the line was thus divided into three tangents. The line as now proposed by the Channel Bridge and Railway Co. is straight and nearly twenty-one miles long. It is composed of seventy-three spans with a minimum clearance above high water of 177 feet. The piers, which, with their foundations, are designed by M. H. Hersent, the noted French engineer, are of braced steel columns resting upon masonry supports founded in caissons within coffer-dams. The coffer-dams, in depths greater than about 100 feet, rest upon a foundation of concrete slabs. The mean depth is 120 feet, and the maximum 167 feet. The estimate of the time required for construction has now been reduced from ten to seven years, and the estimated cost from 172 to 134 million dollars, the reduction being chiefly in the item of substructure. The designs were the joint work of Messrs. Schneider and Hersent in France, and of Sir John Fowler and Sir Benjamin Baker in England.

THE design of the foundations and substructure of the Channel bridge is but one of a formidable array of important engineering works in which M. Hersent, either alone or in coöperation with others, has been engaged in the course of his active career of nearly forty years. Among these works the execution of foundations for bridge-piers and quay-walls by means of compressed air forms an important part. Among these we find the bridges of Argenteuil, Orival, and Elbeuf, over the Seine; the Stadtlau and Franz Josef bridges, at Vienna, and the bridge at Linz, over the Danube; the Rhine bridge at Kehl (1859–60), and many others of importance. The improvement of rivers, the construction and improvement of harbors, with the necessary removal of rocky and other obstructions, and the building of docks, locks, and quay-walls, have also engaged a large share of M. Hersent's attention. Prominent among works of this character on which he has been engaged are the regulation of the Danube at Vienna (1870–75), the harbor of Toulon, involving the construction of dry-docks by means of immense metallic caissons, the new harbor works of Antwerp, including 3500 meters of quay-walls on pneumatic foundations, rock-removal and dredging at Cherbourg, the construction of a dry-dock at Saigon, Cochin China, and the reconstruction of the harbor of Lisbon, with 10 kilometers of quays, a system of hydraulic cranes, dry and wet docks, etc.

At present, M. Hersent's firm is engaged in two notable harbor projects: that at Bizerte, in Tunis, and that of Bordeaux. Bizerte—the ancient Hippo-Zarite—lies

due south of Sardinia and west of Sicily, just west of the point where the southern or African shore of the Mediterranean makes a right-angle and falls off to the south. It is connected by railway with Bône (where Messrs. Hersent et Cie. have constructed quay-walls) and with other points along the north coast of Africa, and, judging from a beautifully illustrated "Bulletin" issued by the Compagnie du Port de Bizerte, it is evident that its attractions for tourists are to be utilized in its development. The town lies directly on the seashore and on the side of a short and narrow inlet leading to two lakes which lie just back of the town. The nearer portion of the first of these lakes is to be separated from the rest by means of a dam and will form a well-protected harbor. The works will consist principally in the regulation and rectification of the inlet and the construction of quay-walls to protect its entrance. The work at Bordeaux consists in the construction of 1600 meters of quay-walls resting upon masonry piers sunk by the pneumatic process, and embraces 63,000 cubic meters of masonry, 140,000 cubic meters of rock-removal, and 400,000 cubic meters of dredging.

Mr. Georges Hersent, son of this distinguished engineer, has, since his visit to the World's Columbian Exposition, made a tour of the United States and of the isthmus of Panama, visiting California, the mouth of the Mississippi, etc., in order to make a study of the conditions existing here.

PROFESSOR BARKHAUSEN has contributed to the *Zeitschrift des Vereins Deutscher Ingenieure* an account of his visit to the United States and to the World's Fair. He gave special attention, during his stay here, to matters connected with iron and steel construction, and his report includes interesting illustrated descriptions of our methods of bridge- and roof-construction, including hand and machine riveting, eye-bars and pins, etc.

THE engineers of America, and especially the "eighty-niners," or those who visited Europe in 1889 for the purpose of seeing the Paris Exposition, and who shared in the magnificent courtesies extended to American engineers by their European brethren in that year, had made preparations in the hope of being able to visit their appreciation of those hospitalities upon the hosts of European engineers who, it was believed, would visit the World's Fair more or less completely *en masse*, as the American engineers visited Paris. Much to the disappointment of the would-be hosts, however, only one distinct body of engineers visited the United States in that connection. This was the delegation of the Société des Ingénieurs Civils de France, which arrived at New York early in September and sailed away about a month later, having spent about ten days at the Exposition and having visited Niagara, Detroit, St. Louis, Pittsburgh, the Pennsylvania oil-regions, Washington, and Philadelphia, while a few, who remained longer, visited Boston and made a short trip into Canada.

M. Jousselin, the president of the society,—of whose death we have since learned from a correspondent in Paris,—was detained at home by illness in his family, and the delegation was headed by Mr. Louis Rey. This gentleman has contributed to the Mémoires of the society a full and interesting account of the visit. Unfortunately their steamer reached New York harbor just after sundown, and thus, to the forcible impressions which one gets of our protective-tariff system during a detention of an hour or so on the inhospitable wharf at Hoboken, these visitors were enabled to add those gained by an enforced night's stay on shipboard while the customs officers slumbered comfortably at home. The next morning, however, the outstretched arms of the Bedloe's island statue, erected by their own countryman, must have gone far to assure them that they had, after all, reached a free country. A ride upon a New York Central locomotive, on the way to Albany, impressed the visitors with the smoothness of its running, which they attributed largely to the height of its center of gravity above the rails. The fact that one of their number occupied at the Auditorium, in Chi-

cago, a room with a number exceeding 1900, gave these visitors a realizing sense of the dimensions of that caravansary.

The report refers to "a very original discourse" addressed to the party by the late Mayor Harrison, at Chicago. The speaker, we have heard, remarked that as America is the greatest country in the world, as Chicago is the greatest town in America, and as he was mayor of Chicago, it followed that he was the greatest man in the world. It is difficult to believe that even a Chicago mayor could have meant this seriously, but our French friends took it so, and we are thereby reminded of Dr. Holmes's wise remark that it is not what we say, but to whom we say it, that counts.

M. JOUSSELIN was born in 1830 and was for many years in the service of the Paris, Lyons, and Mediterranean railway, where he distinguished himself in the field of signalling, introducing an electrical apparatus of his invention. He was a man of most estimable character, and was most highly esteemed, not only for his technical attainments but perhaps equally for his readiness to aid those who were working upward on lower rounds of the ladder. Our correspondent writes that M. Jousselin "left behind him nothing but regrets." We trust this need not be taken quite literally, as is, however, too often the case with distinguished engineers, especially with those who allow themselves to have a thought for the success of others.

IN Germany, too, the great archer, Death, has been proving his proverbial fondness for a shining mark. The death of Franz Grashof, on October 26, was followed, on November 25, by that of Johann Bauschinger, and thus, within a month, the profession lost two of those bright and shining lights who have done so much to establish the fame of the German engineers as among the foremost investigators and thinkers in practical science.

Grashof, born in July, 1826, was scarcely second to Bauschinger in their common pursuit. He succeeded Redtenbacher at the school of machine-construction of the Carlsruhe Polytechnikum in 1863, and remained one of the faculty of that institution until his death. He was five times elected its director. An apoplectic stroke in 1882 greatly curtailed his activity, yet we find him serving, in addition to his other duties, as a member of a normal commission of measurements since 1882 and as a curator of the Royal Physical and Technical Institution since 1887. To American engineers he is perhaps best known through his great works, "Theorie der Machinenlehre," "Theorie der Elasticität und Festigkeit," and "Resultate der mechanischen Wärmetheorie." He was a director of the Verein Deutscher Ingenieure (Society of German Engineers) from its foundation in 1856 until 1890. The organ of the society, in commenting upon his life and death, says: "For many years Grashof was in fact the embodiment of the society, so intimately had he become associated with it, so incontestable was his influence upon its life."

Bauschinger, who, at the time of his death, was a man of sixty years, was the leader of German investigators of the strength of materials. He was at the head of the mechanical and technical laboratory of the Royal Bavarian Polytechnikum, whose "Mitteilungen" (communications) form part of the classics of that branch of engineering science. This laboratory is to the Germans what Watertown is to the United States, and no great line of study upon strength of materials was there undertaken but Bauschinger must be in the van. He was profoundly interested in the work of the conferences for the unification of methods of testing materials of construction, and to him belonged the credit of their success. Twenty-one of the Mitteilungen have appeared, and at the time of his death the distinguished author was laboring upon the preparation of the twenty-second, which was to contain a further discussion of the behavior of wrought iron under repeated stresses, with a refutation of Autenheimer's hypothesis. Bauschinger was also a professor of graphic statistics, and his work on that subject, published in 1871, is well known to the engineering profession.

PROFESSOR TYNDALL was perhaps less closely related to the engineering profession than were these two great German students, but he spoke our language, and his death may be to us perhaps even a greater loss than theirs. Certainly those favored few who enjoyed that rarest of all the rare treats provided for the "eighty-niners," the lunch with Tyndall in his home at Haslemere, and who can recall the tearful eloquence with which that grand old man spoke of the brotherhood of engineers and scientists on both sides of the Atlantic, can regard his death as nothing less than a personal bereavement.

THE last few months have seen a radical change in the appearance of the Delaware river in front of Philadelphia. Until within the time named, the channel has been obstructed by the presence of two islands—Smith's and Windmill by name—with a combined area of about twenty-five acres. The two islands, originally one, formed an obstruction about a half mile long in the axis of the river, and greatly interfered with traffic between Philadelphia and its opposite neighbor, Camden, on the New Jersey side of the river. For this reason a canal was many years ago cut through, dividing the island into two portions and offering a passage-way for the steam ferry-boats plying between the two cities. The northern portion, called Smith's island, has from time immemorial been a place of popular resort, formerly for the mixed population of men and boys who infested the districts lying near the wharves of both cities, and, more lately, under the name of Ridgway Park, for a perhaps somewhat more select clientage. Upon the southern portion, or Windmill island, stood several manufacturing establishments, while its extreme lower end was for some years occupied by the Sanitarium, a charitable resort for sick children. The islands have now been dredged away to a depth of about twelve feet below low-water mark, and their removal will admit of and be followed by a considerable extension in the length of the wharves on both sides of the river, the object of which is not only to give increased wharfage, but also to reduce the channel to approximately the same effective width as it had before the removal of the islands.

The discovery, within a few weeks, of the remains of an old schooner at about low-water level, seems to indicate that the islands in their present shape may owe their existence to the presence of this obstruction. About a mile and a half further up stream, and opposite to Cramp's shipyard and the great coal-wharves of the Philadelphia and Reading railroad, or at about the extreme northern end of the port of Philadelphia, lies Petty's or Treaty island. This island, about two miles long and much wider than Smith's or Windmill island, is nevertheless, owing to its location, a less important obstruction to navigation. About 1000 feet of its western side are however being dredged away, so as to give a uniform width of channel of 1900 feet between the island and the Philadelphia shore. At the same time operations are in progress for cutting off the eastern channel between the island and the New Jersey shore, in order to confine the current to the western or Philadelphia channel. A pile and stone jetty, for this purpose, is now nearly completed.

A pile jetty is also being constructed at the mouth of the Schuylkill river where that stream enters the Delaware river, at the southern end of the city. The object of this work is to prevent the submergence of certain mud flats at that point, and thus to confine the entire current within the channel proper. This jetty is so located as to exclude as much as possible of the flood tide. Major Raymond, by locating the jetty in this way, flies in the face of the established theory governing such matters. His argument, however, is that in this case the flood tide brings all the sediment, while the ebb and the freshets, owing to the presence of Fairmount dam a few miles up the river, are comparatively free from sediment. Major Raymond's theory is strengthened by the fact that in numerous cases where jetties were perforce located in this way, excluding a large portion of the flood tide, a deepening of the channel resulted.

MR. HOECH points out that our rendering of his remarks in describing the North Sea and Baltic ship-canal, as given in our January issue, is liable to misconstruction, inasmuch as it conveys the impression that the emperor had, by mere fiat, arbitrarily modified the designs of the engineer. What Mr. Hoech wished to express was that the emperor had expressed the desire that a second railway-crossing might be accomplished by means of a high-level iron arched bridge, like the one already executed at Gruenenthal, whereas the engineers, from motives of economy, had proposed a draw-bridge for the second crossing. It eventually transpired, however, that the construction of the canal had been carried out so economically and the cost kept so far within the appropriation, that it became practicable to carry out the emperor's acceptable suggestion.

THE Midland and Great Northern railways, of England, which have bought up the Eastern and Midlands, are reconstructting the bridges of the latter so as to bring them up to the standards of the new owners. Mr. T. Graham Gribble, the former conductor of this department of the Magazine, who is engaged in this work, informs us that the load-assumptions are much heavier than those employed in America, and that the dead weight is included, to allow for corrosion.

MR. JAMES F. SMITH, a veteran civil engineer, celebrated Christmas Day and his eightieth birthday at the same time, in Reading, Pennsylvania. Mr. Smith is ex-president of the East Pennsylvania railroad, and was for many years president of the Schuylkill Navigation Co. The festivities were attended by a large number of sons and grandsons, most of whom are engaged either in active engineering or in the service of transportation companies. Among these was Mr. Edwin F. Smith, son of the veteran, who is superintendent of the Philadelphia and Reading Terminal in Philadelphia.

ON November 1 the Italian railways, by royal decree, adopted the time of central Europe, which is one hour faster than Greenwich time, and 50 minutes 39 seconds faster than French railway-time, or that of the meridian of Paris. The twenty-four hour system was also adopted at the same time, the hours numbering from midnight to midnight, so that members of the American Society of Civil Engineers may reflect, as they read their notices of meetings to be held at 20 o'clock, that they are not alone in the world.

IN this Department last month a brief reference was made to the appearance of Mr. Suplee's translation of Reuleaux's great work, "Der Konstrukteur." Since that time, the translator has presented to the American Society of Mechanical Engineers a handsome full size portrait of the author. The portrait, which is the work of Mr. Suplee's sister, will now grace the same room with that of the great English scientist and engineer, Professor Rankine.

THE contest over the secretaryship of the American Society of Engineers has resulted in the reëlection of Mr. F. Collingwood, by the unprecedentedly large vote of 501 to 339. His opponent, Mr. C. W. Hunt, has for some two years served most efficiently as assistant secretary. Mr. Collingwood's handsome majority over his very able and popular assistant, who had, moreover, the advantage of being the candidate of the nominating committee, is a fitting acknowledgment by the Society of the fidelity and efficiency with which Mr. Collingwood had discharged his arduous duties during the three years of his incumbency. That gentleman has very generously signalized his reëlection by presenting to the Society a bond for $1000, the interest of which is to be applied to the payment of premiums for papers presented by Juniors of the Society, his very commendable object being to encourage a wider participation of the Junior class in the activities of the Society.

A COMMISSION appointed in May, 1890, by the French minister of public works to study the subject of curve resistance, has made its report. Their principal experi-

ments were made upon a specially constructed experimental kite-shaped track at Noisy-le-Sec, on the Eastern railway. The dynamometric pendulum of M. Desdouits was used for recording the accelerations and retardations of the vehicles, from which the resistances were readily deduced. The track contained curves of 100, 150, and 200 meters (328, 492, and 656 feet) respectively. No increase of curve resistance with velocity was noted, up to velocities of 45 kilometers (27 miles) per hour, which is about the maximum velocity used upon the system. It was found that tight couplings gave the least resistance, and (as might have been expected) that considerable reduction of resistance followed the introduction of parabolic transition curves and the superelevation of the outer rail.

THE General Direction of the Austrian State railways has recently been erecting some remarkable stone bridges in the steep and rocky valley of the river Pruth, in Galicia, on the northeastern slope of the Carpathians. One of these, with a span of 213 feet, is exceeded in this respect only by the famous Cabin John (aqueduct) bridge near Washington, with its span of 220 feet, and is believed to have a greater span than any other stone railway bridge in the world. Nevertheless, the engineers confidently announce their conviction that in the near future even this great span will be thrown into the shade by greater ones.

IN the work on the Delaware Breakwater, at the mouth of Delaware bay, Major Raymond has been carrying out some interesting experiments upon the angle of slope of broken stone deposited at random under water. In constructing a dike to connect the ice-breaker with the breakwater proper, he departed from the usual practice of first depositing the stone over the entire width of the base of the structure, and confined the scow, from which the stone was dumped, in such a way that all the dumping was done within the width of forty feet, which is the top width of the dike to be built. The resulting slopes were carefully measured and it was found that upon the harbor or upstream side the slope was 1 in 1.3, while upon the outer or seaward side the slope was 1 in 2. The latter is so remarkably steep, in view of the action of the seawaves, that further developments will be awaited before proceeding with construction based upon it, but the inner slope of 1 to 1.3 is found to correspond very well with that of other works. It is therefore proposed to proceed at once with the construction of a wall built upon that side of the dike.

AT a recent meeting of the American Society of Civil Engineers, Mr. C. Robert Grimm, late engineer for the Tacony Iron and Metal Company, and the designer of the iron superstructure erected by that company for the tower of the new Philadelphia City Hall, gave a description of this work, the lower, or prismatic, portion of which has been in place for a year or more, while the pyramid which is to surmount it still stands in the yard of the builders at Tacony, no doubt pending the final settlement of the dispute, now before the supreme court, between the city authorities and the building Commission, as to the jurisdiction of the building. The iron work, comprising the octagonal prism and pyramid already referred to, consists only of upright and inclined rafters, braced by internal octagonal rings and braces in horizontal planes, and without trusses properly so-called.

"FLIEGENDE BLAETTER," the German comic paper, has a highly humorous illustration, showing a suggested utilization of a sawfish as a sawing-machine for cutting off logs under water. The log shown is horizontal, but after reaching so high a degree of perfection in the training of animals, it would surely be a small matter to induce the fish to work lying on his side, so that the method could be applied to the cutting-off of piles.

AMONG the minor exhibits of engineering interest at Chicago, and one from a part of the world and from an age where we do not ordinarily look for such items, was a model of a cantilever bridge of 161 feet span, at Amioto, Japan, built in 1662.

MINING & METALLURGY

Conducted by Albert Williams, Jr.

ALMOST every newspaper in Colorado makes an attempt at the close of the year to figure up the State's bullion output. There seems to be a competition between the several papers, each attempting to run up the totals a little higher than its rivals dare aspire to; to which motive must be added that of local State pride. It is an interesting study in statistics to compare the figures presented. One Denver daily foots up the total value of the silver, gold, lead, and copper produced in Colorado in 1893 at $30,000,000; another makes it $31,600,000; a third climbs up to $46,000,000. This Department has no means of ascertaining which is the nearest to the truth. Mr. W. C. Wynkoop, editor of the weekly *Mining Industry* (Denver), has kindly furnished an advance statement which will come very close to the actual total, the compilation including all sources except a return from one smelter for which the discrimination between Colorado domestic ores and imported ores is in doubt. The figures stand as follows:

Silver, troy ounces	27,610,492
Gold, troy ounces	355,300
Lead, tons of 2000 pounds	59,882
Copper, pounds avoirdupois	7,502,765

The average valuation for the year would be: Silver, 77 cents per ounce; gold at the standard coining rate, $20.67; lead, $72.30 a ton; copper, 10 cents a pound, making:

	Market price.
Silver	$18,327,344
Gold	7,364,721
Lead	149,115
Copper	75,028
Total	$25,916,208

This is a very unexpected showing, considering the depression in the silver and silver-lead industry during the latter half of the year.

THE suspension for one year of the operation of that provision of the United States mining law which requires $100 worth of work to be performed annually upon each mining claim is generally approved of, and of course by the owners of such claims. It is intended as a measure of temporary relief, and may or may not be made perpetual at the conclusion of the one-year term. In the present depressed condition of the silver industry, taking off the $100 "assessment-work" requirement is doubtless commendable, as the majority of the locators and holders of mining claims are poor men. It may be remarked in passing, however, that this assessment-work business has often complicated the question of titles, owing to the irregular and lax way in which the law has been complied with, the performance frequently being simply a farce. But the expediency of permanently annulling the requirement is much to be doubted. The object of the law, of course, is to prevent a single person from monopolizing a large number of claims, or even holding a single one, and allowing them or it to remain idle. The United States law of 1872, with all its manifest defects, certainly does not err on the side of illiberality to the discoverer or holder of mining ground. Indeed, it is far more liberal than that of any other country. The assessment-work feature, with others, was derived from the mining laws of Mexico. The policies of the two countries, however, are not wholly alike. In Mexico, where it was not expected that many new locations would be made, but where an immense amount of known mineral ground was already located, the object has been to compel, so far as law could effect it, the mines to be worked, in order that the country as a whole might gain by the

increased yield of its most valuable product. Hence the law there is pretty stiff. In the United States, on the other hand, at the time our mining law was framed there was an immense area of practically unexplored country which it was desirable to open as rapidly as possible, and hence there was reason for holding out every inducement to the prospector and miner. At present our law does not fit the conditions and is generally disapproved by mining men. It must in time inevitably give way to a simpler, more rational system. As to the assessment-work clause, it is well enough to suspend it under existing circumstances.

AN example of remarkably good tunnel-driving is furnished by recent records of the Palisades railway tunnel on the New Jersey side of the Hudson river. This tunnel is the most important railway-tunnel enterprise now under way in America, considerably exceeding in dimensions the Busk-Iranhoe, which has just pierced a divide of the Rocky mountains in Lake and Pitkin counties, Colorado. The work is being done by the New York, Susquehanna, and Western Railroad Co., for the purpose of giving their road a New York terminal. The contractors expect to "hole" the work about the time this notice will be read. They have been at work about a year. For the following data this Department is indebted to the courtesy of Mr. William L. Saunders, of New York. The tunnel is about a mile in length and is being driven through the hardest kind of Jersey trap-rock. The dimensions are 27 feet wide by 21 feet high. Mr. P. F. McLaughlin, who has charge of the east end, after careful experiment, has adopted the single-shift plan of drilling and blasting. Headings are usually driven by machine-drills placed on columns,—commonly two columns in each heading and from one to two drills on each column. It is usual to work day and night,—that is, two shifts per 24 hours. In view of the fact that after each blast quantities of broken stone are thrown about the heading, considerable time elapses before this muck can be cleared away, so that the drills can be mounted and properly worked. The result of this is that high-priced men, like drill-runners, do a good deal of mucking and several hours sometimes elapse before the drills have been properly put to work. Mr. McLaughlin's plan has been to economize in the cost of driving by running the drills during one shift per 24 hours, blasting at the end of this shift, and then employing common muckers to clear away the heading and to prepare, under the direction of the foreman, the columns and drills so that when the drillers come to work they immediately take charge of the machines and begin the work of drilling. With this plan Mr. McLaughlin succeeded during November in making a record of 161 feet of clear heading and 186 feet of bench. This work was done with four Ingersoll-Sergeant F-2 drills in the heading and six on the bench.

AS compiled by the *Iron Trade Review* the total lake shipments of iron-ore during the season of 1893 were 5,836,749 long tons, as compared with 8,345,313 tons in the corresponding period of 1892, with 6,444,440 tons in 1891, and with 8,063,067 in 1890. Meanwhile the stock of ore on dock at the lower lake ports December 1 reached 4,070,710 tons, or about the same as in the preceding year at the same date. Taking these figures together, in the light of the extreme depression in iron production during the last half of 1893, the showing for the lake ore production is larger than might have been expected. It is supposed that the all-rail shipments of Lake Superior ore to the close of the year brought the aggregate to nearly 6,500,000 tons. The statistics of the Lake Superior iron-ore region for the last eleven years present a history of extraordinarily extensive mineral resources and of enthusiastic —perhaps too enthusiastic—development of them. The *Iron Trade Review* considers that, while only conjecture can estimate the iron-ore output for the current year, the position of stocks on dock is much more favorable than last year, since the stocks on hand at furnace have been so greatly reduced of late months. The outlook for iron-ore mining in 1894 is still

a critical one, dependent, as is the whole iron and steel trade, upon the general business and financial condition.

THE coke trade is reported by the *Colliery Engineer* to be in a deplorable condition. Shipments are slowly increasing, but prices are being cut on all sides and coke is selling at ruinously low prices. More ovens are in blast in the Connellsville region than in the autumn, and sales have increased, but this is due more to the fact that coke consumers are taking advantage of the extremely low prices than to any legitimate demand for consumption.

SPECIMENS of ozocerite, the so-called mineral wax or native paraffin, have been frequently found on the Pacific coast, in the neighborhood of Puget sound and along the Columbia river. The source is now believed to be in the lignite-beds of the region, and the present value of the mineral warrants careful exploration. The demand, principally for making the insulating material okonite and for varnish, has caused the importation of Galician ozocerite to the amount of over a million pounds yearly. In this country a small but increasing quantity is obtained from the deposits near Thistle, Utah, the yearly output ranging between 50,000 and 100,000 pounds, though in 1890 a yield of 350,000 pounds was reported. The price, $100 to $150 a ton, would permit it to be profitably shipped from any point in the United States where it may be found in quantity to the eastern market.

IT is expected that the opening of the coking-coal fields of Sonora will not only stimulate the smelting industry of Mexico, in the branches of lead-, copper-, and iron-smelting, but help the business of copper-smelting in Arizona, and perhaps build up a large silver-lead smelting industry there provided the market for silver and lead improves. Newspaper reports state that Arizona copper companies are figuring on getting Sonora coke at $6 to $8 per ton on outside figures.

TAMARACK NO. 3 shaft, Keweenaw Point, Michigan, was down 3640 feet vertically on December 1, 1893. At the average rate of sinking, 75 feet per month, it had reached a depth more than 3700 feet at the beginning of the year, making it the deepest metal mile in the world, though, according to the *Engineering and Mining Journal*, there is a Belgian coal-mine for which a vertical depth of 3900 feet is claimed. The Yellow Jacket shaft, on the Comstock lode, Nevada, was sunk to 3040 feet. From the deepest levels of the Comstock some winzes were put down to still greater depths. These are all now under water, however. The Maria shaft at Przibram, Austria, was 3675 feet deep at the time of the great fire in the mine in 1892, since which time it has not advanced. The Adelbert shaft, in Germany, was the object of a popular demonstration and festival when it acquired a depth of 1000 meters (3281 feet). But the Tamarack No. 3, in the copper region of the upper peninsula of Michigan, appears to hold the record for deep metal mines.

AN engineer who is very familiar with the ground writes over the signature of "Inquirer" to the *Engineering and Mining Journal* a criticism on the management of the Tamarack copper mining company, of Michigan, which calls up an old and much-vexed controversy, namely, the question of policy in opening mines of rather flat dip—in this case 38° to 39°—from the horizontal. The point at issue is stated in the caption of the letter: "inclines on the vein [bed] versus vertical shafts and crosscuts." The Tamarack differs from mines located under the United States law of 1872,—commonly known as the rule of the apex,—in that it has no apex, being held under the Michigan law of "square locations," by which is meant that mining ground is owned on the same principle as other real estate. In other words, the holder can follow his vein or bed down to any depth at which end and side lines extend in vertical planes, but is prohibited from going beyond his side lines. This law, by the way, is the sensible, logical one, for it places titles on a sound basis,—that of surveyors' measurement, which can

always be verified. The Tamarack adjoins the Calumet and Hecla ground, but to reach the ore-bed required a very deep vertical shaft, or else some arrangement with the Calumet and Hecla people to reach the ground of the Tamarack through the workings of the former, or at least a site upon Calumet territory from which to sink an incline. The No. 1 Tamarack shaft was started near the boundary line, with the idea of tapping the ore-bed within reasonable depth, and as a sort of compromise between the proving of a theory and obtaining financial resources to cover tedious dead work, and to secure dividends within the shortest time. Up to last May the mine has paid $3,470,000, and from that point of view the investment was a decided success. Now that the theory (that the Calumet bed extended continuously into Tamarack ground) has been proved, one can see how a better policy could have been pursued. At the time, however, the enterprise was regarded as somewhat hazardous, and the boldness of the projector was looked upon with some disparagement. Before the work was undertaken Captain Daniels made a trip through the western mining districts, and what he saw there must have impressed him with the belief that vertical hoisting was the right thing. It is the same problem that has been fought over on the Comstock, where (the dip averaging about 40°) one row after another of vertical shafts was put down, the last but uncompleted shaft, the Forman, having been planned to tap the foot-wall (there is no hanging wall, only broken country) at about 4000 feet. Some of the vertical shafts, after passing through the lode, were continued as inclines with round, separate cables and giraffes, but at great disadvantages. But the Comstock is an exceptional case. There is little motive for close figuring where the conditions are a huge gamble as to ore, as to water, and as to the inclination of stockholders to pay Irish dividends. Tamarack has been obliged to follow the same example, though from different reasons. No. 1 shaft cut the bed, when long cross-cuts became necessary. The requirements called for a second and a third shaft. Now "Inquirer" complains of the long cross-cutting and the extra cost of haulage. His remedy is an alternative one: either "install an electric underground plant for the long trams on the vein and to No. 1 shaft; and, second and more important, change the course of No. 2 shaft before it is too late to be of commercial value to the mine, so that these increasing tramming distances may avoided by having the shaft underlie the vein, or run in it, if practicable." The former proposition is most commendable; or a substitute might be suggested in a wire-rope transmission from the surface. But to alter a vertical shaft to an incline, putting in an elbow as it were, has been proved to be a most awkward arrangement. William Patton, a mechanical engineer before becoming a miner, who was superintendent of the Consolidated Virginia-California-Ophir group, and later of the Broken Hill Proprietary (of Australia), speaking to the writer of the Sutro tunnel, summed up the question between vertical hoisting and pushing cars by saying that he would rather hoist 1000 feet than wheel 2000 feet. Applying this dictum to the case of inclines versus downright shafts, the latter would have the advantage. "Inquirer's" objection would not hold if an improved system of underground haulage were put in the Tamarack. Of course if one could only see ahead far enough and had plenty of money to spend in dead work, he would plan a completed mine, as it would appear after the lowest depth and the longest drift had been attained, after the ore had given out, or the company had failed. But this is just what cannot be done, and it is one of the inevitable and regrettable drawbacks of mining that hindsight comes too late.

AMONG the noteworthy mineral resources of Minnesota are the large deposits of red and brown mineral paint (hematite and limonite) along the banks of the Minnesota river. This material was mined and utilized so long ago as 1867, though on a small scale only, and now renewed interest is being taken in its devel-

opment. The ochers, umbers, siennas, and "metallic" paints annually mined in the United States amount to from 40,000 to 50,000 tons, worth, crude, over half a million dollars. They are produced in very many districts over a wide geographical range, and still hold their own in popularity on account of cheapness and durability. There are doubtless many deposits of red and brown iron-ores, manganese-ores, high colored shale and slate, soapstone, etc., now not utilized, which might be availed of in the manufacture of natural pigments. At present the greater part of the product comes from Pennsylvania, New York, Maryland, New Jersey, Virginia, Tennessee, and Wisconsin.

In regard to the supposed lost art of hardening copper, referred to by Mr. Pentz in the November issue of this Magazine (page 256), attention may be called to one case about which there has been much needless controversy. The copper implements left by the ancient miners of the Lake Superior copper region have been claimed to have been hardened by some unknown process. These relics, of which the most important are hatchets or adzes, certainly were nearly all, and perhaps all, hammered out from pieces of native copper, and the makers of them were presumably ignorant of the art of casting, still less of alloying; though some aboriginal copper adzes in the Smithsonian collection look as though they might have been cast, as it would seem difficult to produce the shapes by hammering. Besides, this native copper is exceptionally pure. While there was no sufficient basis in fact on which to found an argument in favor of the lost-art theory,—for the few specimens are entirely too valuable to use up in testing,—an explanation which seems to be a reasonable one is that the copper has become hard superficially, just to the depth of the thin film of alteration that has in the course of time formed upon it. Along the cutting edge of a hatchet, for instance, there does seem to be a sharpness and hardness not natural to pure copper; but on close inspection the edge is seen to have a coating of some secondary mineral, perhaps a silicate, having a greater hardness than pure copper. Ancient copper tools and weapons from other regions, that plainly were cast, and which contain small percentages of other metals (mainly tin or iron), but not enough to constitute a regular bronze, are very likely to have been accidental alloys, not intentional ones. This could easily happen (in fact it would be strange if it did not) because of impurities in the ores, which impurities were about as likely to act favorably as unfavorably. It required considerable technical skill to make a true bronze.

A chemist who has made a special study of the composition of ancient copper and bronze implements, and to whom this question of the mythical lost art of hardening copper was referred, favors this Department with the following notes: "Some native coppers contain small quantities of iron tin, etc., which would make them harder; but the notion of an unknown method of hardening probably arose from a wish to explain the sculpturing on the monuments in South and Central America, as there were no iron tools there. Now we know that these stones could have been cut by stone implements without the use of metal tools. Mr. J. D. McGuire has succeeded in making a number of similar objects by means of other stones, has bored holes in them with wood and sand, etc., and says that monumental sculpture could be easily done with stone tools by pecking. The copper spearheads, knives, and what not in the Smithsonian museum have a film or coating of green carbonate (?), and apparently a little red oxid, which can be rubbed off."

It is stated that Mexico's largest gold nugget weighed 14⅛ pounds. It is not a little remarkable that on the North American continent, notwithstanding the enormous total output, the nuggets as a rule have ranged so much lower than in Australia. In the "pocket" mines of California, and in various "specimen" mines of Colorado, Idaho, and Montana, some wonderful nests of native metal have been found, but neither in them nor in the

placers anything to compare with the famous "Welcome" and other historical Australian nuggets.

ANOTHER device for finding metallic ores underground is reported. The description published is that "it consists essentially of a coil of insulated No. 18 wire in circuit with a battery and an interrupter. At an angle to this coil is another of fine No. 36 insulated wire in circuit with a telephone which the prospector applies to his ear while holding the coils over the ground." The account goes on to say that "if there is no mass of metal or magnetic ore present the telephone is silent,"—a statement easy to believe, in the absence of any outside cause,—"but if there be, the interruption of the current can be heard by the corresponding currents induced in the telephone." Attempts in this direction have been made from time to time by many hopeful inventors to find mines and reveal buried treasure, but we have not heard of any successful results being attained, though the newspapers often contain glowing promises of what is going to be done. These efforts always remind one of the attempt made by two eminent scientists to locate, by means of the induction coil, the leaden bullet that killed President Garfield. In that case it happened that a woven steel-wire bed was present to vitiate results. So in mines also there are interfering agencies. The novelty of this last reported prospecting invention consists in the application of the telephone. But a series of very carefully conducted experiments, with apparatus of the most refined delicacy, was made in 1880–81 by Dr. Carl Barus on the Comstock lode and at Eureka, in the neighborhood of known and large ore bodies, and the results were negative. An account of these interesting experiments is given in Mr. G. F. Becker's report on the Comstock lode, a monograph of the United States Geological Survey.

AT a Swedish iron-works a method of consolidating steel ingots by the pressure developed by centrifugal force has been in use for two years, and, it is said, successfully; though from the published description it would appear to be applicable only to comparatively small castings. From an account published in the *Industrial World* (Chicago) it is learned that "the apparatus consists of an upright shaft in the center of a cylindrical casting-pit, carrying a frame of four arms, to each of which is jointed a platform supporting four ingot molds. While the shaft is at rest the molds are upright and are filled in the usual way; but when it is set in rapid rotation they fly up into a horizontal position and a pressure is developed in the length of the ingot equal to thirty times that due to the column of liquid metal in the mold, which drives the gases out and," the *Industrial World* reports, "produces a perfectly solid casting." The method is certainly an ingenious one, but it hardly promises to solve the great problem of the day in steel metallurgy, which is to produce sound, solid castings of the sizes needed for armor-plates, propeller-shafts, etc., that will not require forging by the steam-hammer or hydraulic press, but be made at a single operation and need only the application of a finishing tool. The solution of this problem is one of the things that conservative metallurgists deem to be among the impossibilities and that enthusiasts believe are going to be accomplished some time in the indefinite future. If the latter view proves to be the correct one, the result will probably be attained by the introduction of untried alloys and by small changes in the composition of the metal; that is, by chemical rather than by mechanical means. And if such a thing is possible on the large scale it would not only do away with elaborate complication of built-up ordnance and similar expedients, but also with the heaviest and most expensive machinery of existing steel-plants.

MACHINE SHOP PRACTICE

Conducted by Albert D. Pentz.

MR. JOHN RICHARDS writes in *Industry* (San Francisco) for December:

Mr. A. D. Pentz, in the section on Machine-Shop Practice in THE ENGINEERING MAGAZINE for November, complains of sockets to hold machine-drills, and with reason, but he is wrong in assuming there are no good "chucks" of the kind. We once made a drilling-machine, not a "press," for Mr. Wilson, of the Southern Pacific Railway Co., provided with sockets to receive shanks not less than one inch in diameter, the socket portion slightly tapered, flattened on one side to receive a through key mortised through at one side of the bore. The sockets fitted into the spindle in the same manner with a diameter of one and one-half inches or more. The machine has been in use eight years, and we much doubt if ever there has been a failure of its sockets or of the drill-shanks. Size is the main thing. If it were not for expense the square shanks of our forefathers are the best of all.

Now we did not complain of sockets at all, because there is practically no complaint to be made of them. But we did complain of chucks, which are very different things, and which continue to deserve criticism in the particulars specified. There are no good chucks for drill-presses. We do not say that there is no effort made to produce good chucks, because we do know there is a constant endeavor made to get what is wanted. Taper-shanks on drills make them expensive and it takes more time to handle such drills than it does to handle those with straight shanks in compressible chucks. The latter, therefore, are preferred by those who use them in manufacturing for profit. The means mentioned by Mr. Richards seems to be a good one, and we are glad to copy his description of it, but it would not answer in places where a rapid exchange of drills of different sizes is necessary. The square shanks of our forefathers are certainly and happily relegated to the past,—to the time when there was no great need of truth in the movement of drills or of an accuracy to the one-thousandth of an inch in the sizes of holes to be drilled.

A SECTION through, in a drawing, will tell more about the arrangement of the internal details than dotted lines ordinarily can. Therefore, after a sufficient number of side views and a plan have been made,—or, better, an isometrical picture of the device illustrated,—enough cuts should be made through different parts of it to clearly show the inside parts. This practice generally will obviate the necessity for a separate drawing of the full details on experimental work and on tools, where it will be found necessary to draw but few such details of the more complicated shapes. Dotted lines for every covered part are an abomination when made by the average draftsman. Few men have the artistic skill thus to depict the transparent effects so that an intelligent view is given of the internal parts. A section here and there, on the other hand, makes all parts clear and so well within the capacity of the most ordinary draftsman to depict, and in the power of the most crude mechanic to read, that there can be no two opinions as to the advisability of plenty of sections and few or no dotted lines. In a long experience we have found it to pay, as a corrective, to make sections, for many of the mistakes of draftsmen may thus be caught and remedied.

ABOUT one business concern in twenty that starts to build machinery succeeds; the remainder fail or change in shape so as to oust the original projectors. Let us consider the causes of such failures as they have come within our observation. A

frequent cause is bad faith somewhere. Two mechanics, say, save some money and set up for themselves. One of them will at once begin to try to get the control and the other will refuse to submit. The end of such a concern is certain, for no man with self-respect will or can work with another whom he cannot trust. Or an inventor contracts with a capitalist, one furnishing a valuable device to manufacture, the other agreeing to furnish the money. It succeeds, or looks as if it would; then the one most greedy seeks to squeeze the other out and the one who can stand the strain longest gets possession of the business. In neither of these two cases can there be a lasting success for the survivor, because as soon as the schemer gets rid of the worker it stands to reason that nothing can be then produced under commercial conditions. These costly experiments must fail, and they should fail, for no man can keep good faith with his customers who defrauds his colleagues in business. Again, bad faith often exists, where an inventor deceives capital, either as to the value of his device or as to his title to the property in it. In such a case the trouble is short-lived ordinarily, for as soon as the goods reach the market the fraud will be exposed.

SOMETIMES a business is started with the purpose and the expectation of ultimate failure. Thus a pseudo-inventor devises a machine to make a valuable product, which product in itself has been patented by some one else. The machine itself may be new and patentable and, as such, stand the most searching examination. It then is made the nucleus of a stock company by its unscrupulous promoters, and those in the game divide the stock among themselves. Then they start, with a great deal of noise, a "boom," to get people with money interested in it. If this succeeds the stock is quietly unloaded on new buyers until the inventor (? and the promoter have none of it left, and then of course they have no further interest in the concern. The new buyers start a factory in the confidence of making money by underselling the older concern, which owns the patents on the product of both the old and the new machines. When, however, the factory has been built at a large cost and equipped at a much larger cost, and when the machines come out and go to buyers, an injunction will lift its horrid head and crush the life out of the whole business. This game, with infinite variations, is worked continually. If it succeeds it fattens the rogues who engineer it and if it fails there is little lost.

BY far the greater number of failures in the manufacturing business is due to lack of resources. Money and credit are gone before the business is made to pay its way. This is to be regretted, because often every other element of success except money is present in the enterprise.

SOMETIMES a person embarks in a business which his training has not fitted him to manage, and if he is stubborn, or not inclined to take the advice of the initiated, he certainly will fail. We once knew of a business owned by a retired country banker, who managed it himself. The machinery he made was modern and good and could be made and sold at a large profit. But this man's method of doing business was too severe. His correspondence was of such a nature as to imply doubt of every statement made by a buyer who was not prepared to pay cash in full for his purchase. In cases where notes were taken in part payment he would attempt usury. Thus those who might have bought his tools found it more comfortable to do without them, though by going elsewhere they bought an inferior article.

THE chances for successfully starting a small business on small means are growing narrower every decade. In fact, the best advice for an ambitious aspirant to a business for himself is "don't." We know, however, that there are men whose mettle disdains advice, who think for themselves, who can go into business against all odds and succeed to their great glory and renown.

THERE is a way in which to do every

desirable thing. The knowledge of how to do difficult things by simple means is art. For many years we sought for a means to mark oilstones, that is, to place upon them indelibly the names or the initials of their owners so that they could be identified and returned if they accidentally might be found by another fellow in his tool-chest. At last the way to do this was found accidentally. In looking over a box of fine Arkansas stones a little ticket was found, bearing the cost-mark pasted on to one of them. This did not teach anything, but the stone next to it in the box revealed the whole secret. The ticket had been written upon after it had been pasted to the stone, and then it was put into the box with the wet ink in contact with another oilstone. Part of this ink was absorbed by the dry clean stone, as if by a blotter. A moment's examination showed that the color had pentrated deeply into the porous stone. All oilstones necessarily are porous, and colored fluids like ink will penetrate them deeply when they are clean and new. In marking a stone one should use a fine-pointed pen so as to make clear, sharp lines, because the ink will spread to some degree and if the name be written with heavy lines, or in too small characters, the reading of it will not be clear. We would advise that the name be written over the whole broad side of the stone and in very large characters. Such a stone can be used to whet tools ten minutes after it is marked, and it will be worn out before the markings disappear.

WE have been particular in this description to give the details of the finding of this simple and practical means to do a desirable thing well, which thing seemed to us quite difficult before that time, and we wish in this connection to emphasize the value of the habit of considering whether unusual phenomena may or may not have a practical application to the arts. Such simple discoveries as this should be considered with as much care as those that seem at first to be of greater magnitude. When an unusual effect comes to the notice of the writer he considers it from two standpoints, which may be indicated by the two questions: Is this phenomenon needed in any art, and will it do better work than has been done by older means before, or does it do something that has not been done before? Can this new effect be made the nucleus of a valuable new art? Great arts, such as that embodied in the telephone, are seldom born, but every new discovery has in it the possibility of as great an art, if one could but recognize its application to human needs.

AFTER considerable personal experience in the matter, and more of the experience of others of greater familiarity with the subject, we are of the opinion that electric lights of the arc variety are not under any circumstances to be advised for machine-shops. This light is too bright at close quarters. It is too direct and straight. It casts too deep shadows. The great contrast between the fierce light and the black shadows distorts all objects and affects the judgment of workmen in relation to sizes and distances. And it hurts the eyes of the men, perhaps in a short time ruining the sight. Apart from the novelty there is not much to recommend this light. On the contrary, a sufficiency of low-candle-power incandescent lamps well distributed, so as to make a simulated daylight, is a glorious light with none of the objections that condemn the arc lamps. But they are more expensive.

IN the machine-shop a very coarse and hard grindstone is better than any other combination whatever. Since all machine-tools are, or should be, whetted upon an oilstone before use, the edge made by the coarse stone is not important. The coarse stone will cut faster and last longer than the fine one, and of course it is the more economical. Planer-tools should be ground upon a large stone, as small wheels make them too concave for good service. In fact, if planer-tools were not concave at all they would be better for it. Of course the oilstone corrects the concave effect to a minute extent, but it makes no addition to the durability or strength of the edge in the direction of the thrust when at work. Lathe-tools, on the contrary, are rather

improved by being ground concave, because a somewhat stronger point may thus be gained.

IT is doubtful whether the points of turning-tools, or of any other similar cutting-edges for metal, are improved by sharpening them to an angle more acute than fifty degrees. It is certain that all cutting-tools should have not more than five degrees of clearance between the cut and the tool. Hence a planer-tool should have about five degrees' rise, but the workman should be careful not to reduce this in whetting. If lathe-tools were made like planer-tools, and lathes were made to accommodate them, so that the cutting point or edge should be center high only, they would be greatly simplified and more uniform as to their angles. Now some tools are placed at the center—for instance, a side tool or a thread tool. Another is lifted twenty degrees or more above the center. This requires a close adjustment of the tool-post, which sometimes is got at the sacrifice of part of a lathe's capacity. Perhaps this difficulty may be remedied some time by the invention of an inserted tool of simple design, but such a tool is not yet accomplished.

IT is a fact that a ray of light is one of the most unreliable of straight edges in a room lighted from gas-jets, or any other means which provides light from heat or from various points. Light is bent around in curves by many causes as easily and as generally as a flexible spring. Guillemin shows clearly that the disk of the sun is seen for some time after it actually is below the horizon, or set. Any one can see a bright line on the dark edge of a new moon and this means that light is bent over the moon and conveyed around a corner from the sun to the eye that beholds it. In any room where machinery can comfortably be made, the density of the air varies from a great many such causes as artificial heat, motion in machinery, openings such as doors and windows which make currents of air, and the animal heat of workmen's bodies. Hence the light passing through air at differing densities is bent or refracted considerably. Fine workmen in fact do not use light at all to determine straightness. They depend entirely on the sense of touch and on the touch or contact of the part being tested with a straight edge or plane surface. Of course, wherever an absolutely straight and sharp edge shuts out light along a line, that line is absolutely straight if it be situated where light exists to be shut out. However, that is not the condition in question, which is that a line can be found to be straight or crooked by the eye looking along it. It cannot be so found within limits sufficiently accurate for any kind of fine machinery.

THE paper test is a much more reliable one than the light test for the rougher work. The straight edge used should be a parallel one sufficiently wide in relation to its length and rigid so that it may not sag perceptibly over low places. Smooth tracing paper is the best, as it is of uniform thickness and tough. Cut, do not tear them off, strips of paper from a single sheet one-quarter inch wide and two inches long. Place three at least of these pieces of paper at the required intervals across the line to be inspected and place the straight edge upon them. Of course a piece of the paper that may be found loose indicates a low spot, and a very tight one a high spot. If all are tight alike the line is stright if the test edge is. It is obvious, if the straight edge is parallel, and the same result is obtained on both its edges, that its straightness is assured.

SOME workmen make their positions a great deal harder than is necessary. The moment they receive an order or a request to do work in a certain way they at once want to do it in some other way, or want to do some other thing. Now a live manager always is alive to suggestions that may lead to improvement, and is glad to get them, but forever to be met with opposition is one of the most disagreeable things in managing some otherwise valuable men. We know of many men who have no other fault than this one, which sets upon their efforts so heavily as to pre-

vent them from rising above subordinate positions. Again, other workmen are too willing to do all they are ordered to do,—so willing, in fact, that they frequently give their managers the idea that they either do not think about their work at all, or that they are anxious to avoid all responsibility and are lying in wait for an opportunity to perform an operation according to instructions that shall be wrong. This quality of man never rises by his own exertions and seldom by those of others.

ANOTHER fault, and a most un-American one, is that of keeping the processes and details of work a secret from others. This fault is the error that seems to sustain a great many labor societies and makes them engines of injustice where otherwise they could be mighty forces in civilized advancement. What movement leading toward higher wages was ever advanced by trying to corner all knowledge of the art the movement sought to control? In thirty years of experience in the machine business we have seen this error attempted at least as many times, and we are glad to record that failure has followed each attempt to place a tax upon free knowledge.

It seems to us peculiar that generally in machine-tools some essential things and some conveniences will be striven for in the design and got perhaps at the sacrifice of strength or of symmetry, while other things as essential are quite neglected or got in a perfunctory manner without care or inspection. Thus iron planers have two screws to elevate and adjust the rail. These screws may be one a right-hand screw and one a left-hand screw, or both may be of the same kind. They are geared on their upper ends and connected together by a shaft so that both are turned together and raise both ends of the rail simultaneously. Now either there is no great effort made to make these screws lead exactly alike, or the problem is one of considerable difficulty. We believe the latter to be the fact where the screws are right and left, because few lathes cut left-hand screws of exactly the same lead in every part of their lengths as they do right-hand ones. In some planers the lift on one end of the rails is faster than the other, to such an extent that in elevating one foot it is raised higher than the other by three-thousandths of one inch. And it is high-class planers of which we speak. Now this variation is fatal to modern good workmanship and behind the age.

One maker tried to make us believe that this variation was due to the torsion in the shaft connecting the two screws. It was found that this, in a planer inspected, was not the case, but had it been the case it would not have been the remedy, but an explanation of a defect not overcome.

No one appreciates more than we the difficulties in making two screws exactly alike. But no one prescribes screws, for other mechanical devices, such as racks and pinions, or cylinders and metal bands, would serve, and perhaps better. Two racks cut together can be made without sensible variation the one from the other; so can two pinions. Now if these be mounted as they are cut, tooth opposite tooth, on each housing and in the rail, there certainly can be a gear mounted on the pinion-shaft, midway between, that should minimize the torsion to so small a fraction that it could be neglected.

We do not forget for an instant that a careless workman often raises his rail without properly unclamping it; but we are not speaking of defective men, but of defects in tools. We know workmen who have a number of sets of posts, two to a set of exactly equal heights to adjust the rails of their planers upon, when they do particular work.

WHAT a blessing is a good casting. It is soft, so that the tools cut smooth and keep sharp. It is true to pattern, so that none but light cuts have to be made and it matches the seats it is to be bolted to. It is smooth and looks well painted or japanned, or it takes but little polishing to finish it. It is sound and has neither holes in it, sunk spots on its surface, nor "cold shuts" to mar and make it weak. Its cored holes are properly located and smooth.

CURRENT TECHNICAL LITERATURE

THE CONSTRUCTOR: A HANDBOOK OF MACHINE-DESIGN. By F. Reuleaux. Translated from the Fourth Enlarged German Edition by Henry Harrison Suplee. Philadelphia: H. H. Suplee. [Cloth. 4to. xviii-312 pp. $7.50, by subscription.]

THE appearance of an English translation of Professor Reuleaux's famous "Konstrukteur," the work upon which his fame is largely based, and from which nearly every subsequent writer on the subject of machine-design has freely drawn, is worthy of extended notice. American and English engineers who have received a continental training, or who are at least familiar either with German or French, have long since adopted this standard work as an authority in the most practical departments of machine-design, and notwithstanding the inconvenience of using a work written in a foreign language, and expressed in the metric system of measurements, "Der Konstrukteur," of Professor Reuleaux, either in the original German or in the French translation, has found a place in many drawing-rooms of our larger machine-shops and manufacturing establishments.

The present work, however, enables every English-speaking designer, draftsman, and engineer to use the vast collection of data and information, not only in his own language, but also in the notation in which, probably for a long time, his computations must be made. The whole work has been both translated into English and also transformed into the English system of measurements, and for the first time the entire results of Professor Reuleaux's work are placed in the hands of what he himself has characterized as one of the most active and energetic races in the department of machine-construction.

Reuleaux's Constructor differs from most works on mechanical subjects in that it aims to present *results* rather than demonstrations, and, instead of filling the pages with elaborate calculations, the author has given the final results of the researches of practical and theoretical men in all branches of machine-design, in the form of tables, diagrams, or convenient formulæ, and in all cases the practical applications of the methods given are made clear by fully-worked examples showing plainly how the rules are applied and used.

The first section of this work consists of a thorough but condensed collection of data on the strength of materials, and contains tables and formulæ for proportioning all the different forms used in practice to resist the varied action of forces. In this section will be found discussions of bodies of uniform strength, of beams, columns, and vessels of various shapes, and also the proportions of hooped guns, together with a discussion of the proportions of springs. The second section contains the elements of graphostatics, and is the clearest and most compact presentation of this important subject which has yet been made.

The principal portion of the book consists of the third section, which treats of the construction of machine elements. This includes rules, formulæ, and tables for proportioning the various details of all kinds of machinery, so that by the use of the book the correct dimensions and proportions of every part can be obtained. This portion is based both on theoretical considerations and on practical results, and the extensive use by many well-known engineers of the rules and tables here given has proved their correctness and reliability. An idea of the fulness with which these details are discussed will be obtained from the following enumeration of subjects of several chapters: Riveting, hooping, keying, bolts and screws, journals, bearings, axles, shafting, couplings, simple levers, cranks, combined levers, connecting-rods, cross-heads, friction-wheels,

toothed gearing, tension organs (including belting-, rope-, and chain-transmission), pressure organs (including pipes and conduits), reservoirs, and valves of all kinds. The higher mathematics are not used, and all the formulæ and tables are readily applied by any one having an ordinary mathematical education.

The last section of the book contains a collection of useful mathematical tables, showing, by means of illustrations, the various properties of the curves, surfaces, and volumes used in practice, and also some very convenient tables of numbers and angular functions. The work is copiously illustrated and very fully indexed, the index containing nearly 2500 entries.

The translation has been made by Mr. Henry Harrison Suplee, who is well known as an active member of the American Society of Mechanical Engineers, and we cannot better express our opinion of his share of the work than by giving here an extract from Professor Reuleaux's special introduction to the American edition, in which he says: "I take this opportunity to express my particular appreciation of the great care and extraordinary accuracy which he has displayed in the production of this English version, and also my gratification at the care which has been given to the printing and the reproduction of the illustrations. Mr. Suplee has recalculated and transformed all the formulæ and numerous tables into the English system of measurements, and also reworked all the examples, and has shown in this portion of the work a patience which deserves special recognition. I can only add that it is my earnest desire that the friendly acceptance of my book by English-speaking engineers may correspond to the magnitude of the labor which has been expended in the preparation of this translation."

THE INCANDESCENT LAMP AND ITS MANUFACTURE. By Gilbert S. Ram, A. I. E.E. Illustrated. London: "The Electrician." [Cloth. 8vo. 211 p. 7*s.* 6*d.*]

NOTWITHSTANDING that the incandescent lamp has been known for seventeen years, and been in more or less general use for about half that time, its manufacture has been so hedged about with secrecy that little has become known to the public as to the details of its making. In America the processes involved have become better generally known to the public than in England, by reason of a less vigorous prosecution of infringers by the Edison interests, and by the numerous lawsuits involving these processes through which they were necessarily made public. But while almost every step has thus been made public and has been described in our various technicals journals, until the appearance of this work there has not been published any comprehensive treatise on the subject, either in this country or in any other. The recent expiration of the Edison patents in England and their approaching expiration in this country render the present a most appropriate time for the appearance of such a work as the one under review.

Mr. Ram's work is the latest addition to "*The Electrician* series." It is uniform with the two works of J. A. Fleming on "The Alternate Current Transformer" and J. A. Ewing's "Magnetic Induction in Iron and Other Metals," and is mechanically all that is required. Mr. Ram's method of treatment is a logical one, beginning with the filament and following it up with the preparation of the filament, carbonization, mounting, flashing, sizes of filaments (unflashed), sizes of filaments (flashed), measuring the filaments, glass-making, glass-blowing, sealing-in, exhausting, testing, capping, efficiency and duration, and relation between light and power, to each of which he devotes a chapter.

Heretofore the stamp of "*The Electrician* series" has been the highest possible endorsement that an electrical book could bear, and the present work was taken up for review with prepossessions so highly in its favor that perhaps disappointment was inevitable, but that disappointment of the deepest kind followed connot be denied. To start out, Mr. Ram's style is jerky and apparently that of a novice. In the earlier chapters he frequently repeats himself in almost the same words, perhaps on the same page. In describing processes, such as that of carbonization

he gives much space to description of a proper carbonizing furnace which would be much better described by the simple statement that it was a reverbatory furnace of given dimensions or proportions. And much of his descriptive matter relates to things or processes which cannot be described, but must be learned by actual practice. In fact, some of his attempts in this line are very like reading one's instrument finer than the instrumental error. This he frequently does. At times he treats his reader as the merest novice, and at others as an expert. Thus for the expert there is much given that is entirely superfluous, while for the novice there is much given that he cannot understand. But he might be forgiven all this if he were correct. Unfortunately he is often glaringly incorrect in his statements. Take the single chapter on "Preparation of the Filament" as an example. He describes the process of parchmentizing a cotton thread correctly, but all the other processes are wrongly described. He states that the cellulose may be dissolved in chloride of zinc, and the resulting viscous solution, after having been formed into a filament and hardened by squirting through a small hole into alcohol, used at once for the furnace. He says the same thing about what he calls "Crookes's process in which the solvent is cuprammonia." No one can make a filament that can be used in a lamp by either of these processes *as he describes them*. He omits the essential step in each, namely, that after the cellulose has been brought into solution by either of these processes, it must be precipitated again, thus getting rid of the zinc on the one hand and the copper on the other, which, if left in the filament, would render it absolutely worthless on carbonization. And in describing Edward Weston's process (the only one of this kind mentioned) he informs us that he converts the pyroxylin into the material known as *celluloid*. Mr. Weston never did such a thing except, perhaps, experimentally, but he does convert it into *collodion*, and it is not this that he "rolls out into thin sheets," but the reprecipitated *cellulose*, as in the other processes.

It is mistakes of this kind in the beginning of a book that cause the reader to lose all confidence in the author and to question everything else later. But he pulls himself together later on, where he is describing the practice of (presumably) the shop in which he was engaged. He is then apparently sure of his ground, and from Chapter V to the end has given us a very good book, replete with information that is interesting and good. That portion of the book which might be termed a description of his own shop-practice is beyond criticism and, if read as such, valuable.

NELSON W. PERRY.

NATIONAL CONSOLIDATION OF RAILWAYS. By GEORGE H. LEWIS, M. A., of the Des Moines Bar. New York: Dodd, Mead & Co. [Cloth, 8vo, 325 p. $1.50.]

OUR railway problem is so vast, and of such importance to the whole nation, that any intelligent attempt to solve it is to be welcomed, even though not wholly successful. Mr. Lewis does not seem to have had experience in railway management, and is therefore and evidently unfamiliar with many of the perplexing questions which arise in actual practice, but he has given much reading and thought to the problem. Briefly stated, his theory is a compulsory consolidation of all the existing railways into a national company to be controlled by representatives of the present stockholders and bondholders, of the different States, and of the federal government. Present bonds and stocks would be merged into new capitalization on which the government should guarantee 3 per cent. All the difficulties enumerated in the first part of the book would be eliminated, Mr. Lewis thinks. Aside from the momentous constitutional questions involved in such a plan,—the author believes that Congress has such power,—and the further problem of taking the legal control away from the States, it is more than doubtful whether such a plan, if carried out, would have the good effects predicted for it. The wages question, for instance, would be intensified, for switchmen and train men would say that an advance in pay should be granted because dividends were guaranteed by the government. In

like manner every farmer would expect to get lower rates. The inevitable and heavy deficit arising from the increase in operating expenses and the decrease in receipts would have to be met by general taxation.

Although Mr. Lewis believes that rates are a species of taxation, he would undoubtedly hold that taxes ought to be apportioned among those benefited. This cannot be done as to transportation in any way so well as by putting the cost of operating upon the things and persons carried, and not upon the community at large. The truth is that the theory that rates are taxation, while true in part, is liable to mislead. Railway rate-making is a commercial problem, a problem in most cases of prices at two different points, whose difference—profit—must be divided between shipper and carrier. The author mentions this, indeed, but gives little weight to it. The taxation theory is favored by the author principally because of the subtle inference that railways are public highways and therefore properly subject to government control alone. They are public bodies, and they are not. In this contradiction lies our difficulty. In one sense rates cannot be determined by scientific process any more than the price of beef or the butcher's profit. No government ownership could eliminate this commercial element. Are we not better off by allowing these commercial questions to be settled on commercial principles under private ownership? Yes, if concurrently we can also arrange to insist upon the undoubted rights of the public upon the railways. Of course we have not reached an adjustment of these two often conflicting principles of public right and private profit, but it is yet to be proved that government control would help us much.

Minor portions of the book deserve praise and criticism. Mr. Lewis' denunciation of stock-watering is strong, but not discriminating. There is innocent watering as well illegitimate. So it is confusing to find stocks referred to as a "debt" of the corporation (page 16). Again, an accurate analysis of expenses as relates to individual shipments or individual rates, cannot be had. Discriminations in rates—Mr. Lewis thinks—should be made against instead of in favor of towns having exceptional advantages, like water competition (page 94). Yes, perhaps, as as end to be reached in the future, for it is the business of railways to equalize such advantages and so permit the upbuilding of flourishing cities not on the great rivers and lakes; but until earnings permit of such a policy the company must get enough receipts to live on, even if rates be unequal. If government demands an opposite policy it must accept the responsibility and pay the losses incurred.

Mr. Lewis deserves thanks for the fairness which distinguishes his work. Discussion of this sort is always a help to a solution of our railway problem. T. L. G.

BRITISH RAILWAYS: THEIR PASSENGER SERVICES, Rolling-Stock, Locomotives, Gradients, and Express Speeds. By J. Pearson Pattinson. With plates. London: Cassell & Co., Limited. [Cloth. 8vo. 250 p.]

THIS work is written with the intention of discussing the subject of railway traveling from the public point of view. It is an inquiry into the accommodation afforded by the railway companies. The first part deals in a general manner with the subject of railway traveling in England and other countries, and comments on the train services, rolling-stock, safety appliances, speed, and punctuality, on English, continental, and American railroads. In the second volume particulars of the commercial speed of all the leading British lines are given, followed by a description of the locomotives used in express traffic, the gradients over which they run, and the actual work they perform. This is the first book on the subject ever issued in England, we are informed, in which the popular side of the question is treated at length.

A FIELD-BOOK FOR CIVIL ENGINEERS. By DANIEL CARHART, C. E., Dean and Professor of Civil Engineering, Western University of Pennsylvania. [Cloth. 32 mo. 282 p. $2.50.]

THIS book is written for students of civil engineering and meets the demand for a manual convenient in size, systematically arranged, illustrated, and easy of reference. It treats that part of the work of

the civil engineer which will enable him to locate the center line of a railroad, set the stones, compute the quantities, and solve the problems pertaining to track-laying. The various subjects are introduced in the order in which they present themselves in actual work. The first two chapters deal with reconnaissance, preliminary survey, location, and the required instruments. In Chapters III and IV are derived numerous formulæ, and practical problems are proposed, their solutions also being indicated. The next chapter has a set of miscellaneous questions. In Chapter VI, which treats of construction, the difficulties of the young engineer are kept vividly in mind, and simplicity is constantly aimed at. The last chapter is on frogs and switches, and is from the pen of Lewis C. Weldin, assistant engineer Pennsylvania railroad. The book contains all the necessary tables for field use.

ICE-MAKING MACHINES. THE THEORY OF THE ACTION of the various forms of cold-producing or so-called ice-machines. Translated from the French of M. Ledoux, by J. E. Denton, D. S. Jacobus, and A. Riesenberger. New York: D. Van Nostrand Co. [32mo. 190 p. 50 cents.]

THE new edition of the translation of M. Ledoux's valuable essay, which, as published in Van Nostrand's Science series, has proved a useful source of practical information and theoretical suggestion, is designed to make the work more available to American students. All figures have been transformed to English units, and all results expressed in the units commonly expressed in American practice. Footnotes have been liberally introduced to emphasize important points of the text, supply intermediate steps not fully indicated, and to call attention to modifications of the author's views necessitated by recent experience. There are other important additions which we have no space to mention in detail.

INDUSTRIAL ARBITRATION AND CONCILIATION. SOME chapters from the industrial history of the past thirty years Compiled by Josephine Shaw Lowell. New York: G. P. Putnam's Sons.

THE object of the compiler is to present an account of some of the methods by which industrial peace has been attained in many large industries, both in Europe and in America. The book comprises twelve chapters taken from books of different authors dealing with the subjects of arbitration, conciliation, and the trade-union movement in general. The compiler believes that labor organizations are not only inevitable in free countries, but highly beneficent. It is useless to attempt the arrest of the movement, and history shows that laws against such combinations only tended to make the unions lawless and violent. It is better for the employers and society as a whole that the unions should receive due recognition, and that disputes between the employers and their organized employés should be settled by resort to arbitration. The success of arbitration in England, Belgium, and the United States is amply shown by the facts set forth in the book. It is a mistake, however, to suppose that arbitration offers a permanent solution of the labor problem. For such a solution we must look into the principles of land tenure, finance, trade, and exchange.

THE PHILOSOPHY OF THE TOOL. BY DR. PAUL CARUS, Editor of the *Monist* and *Open Court*. A lecture delivered before the Department of Manual and Art Education of the World's Congress Auxiliary. Chicago: Open Court Publishing Co. [Paper. 24 p. 15 cents.]

EVERY one who handles and appreciates tools should read this interesting and philosophical disquisition. Dr. Carus's treatment invests the tool with a dignity and value to which many workers are unfortunately blind. Franklin, by his famous definition of man as a "tool-making animal," not only gave expression to the energetic spirit of American industry, according to the author, but gave a more profound definition of man than any other thinker, for he suggests that man's reason developed by the exercise of reason, that the organ was created by its functions, and that applied reason—work—has been the great educator of mankind. The contempt for the mechanical is irrational, and has been due to a mistaken view of the tool. The tool is not passive; it corresponds to the creative principle. The mechanical is mathematics in motion. The

hand is the tool of tools, speech is a tool. The history of tools and of their invention is the history of the growth of the human mind. We have no space for further samples of Dr. Carus's fine treatment of his subject, but we must give the following suggestive remark of his: "The development of tools . . . as for instance, at the present date, the construction of dynamos and motors, makes toward a certain ideal. When an invention is made, such as the bicycle or the typewriter, we find very soon a great variety of them in the market. By and by, however, they begin to approach one another in form, and in the end, when all the patents have expired, one looks very much like the other, even in the arrangement of apparently accidental details."

STANDARD TABLES FOR ELECTRIC WIREMEN. With instructions for wiremen and linemen, underwriters' rules, and useful formulæ and data. By Charles M. Davis. New York: The W. J. Johnston Co. [Cloth. 32mo. 128 p. $1.]

THIS is the fourth edition of a popular work. Among the important additions that it contains may be mentioned the new insurance rules of the Underwriters International Electric Association, and a section on the calculation of alternating current wiring, which brings this subject within the reach of practical men. Some of the tables given were prepared expressly for this work and cannot be found elsewhere.

CHANCES OF SUCCESS: Episodes and Observations in the Life of a Busy Man. By Erastus Wiman. New York: American News Co. [Cloth. 16mo. 359 p. $1.]

IN these days, when every man is being enclosed in an entirely new set of circumstances, the vigorous lines of Erastus Wiman in the pictures he has drawn are very attractive. Thus an article entitled "The Basis of Things" sets in new colors the utter dependence of the whole body politic on the man who alone produces food and fiber—the farmer. Without foreign trade and its profits, without interest from loans or investments abroad, without gains from maritime commerce, there is no dependence except upon the farmer. Yet by the strong lines of Mr. Wiman's picture the farmer is found to be steadily declining in purchasing and debt-paying power, and revival is impossible until he and the vast class dependent upon him, comprising three-fourths of the population, are in better condition. Another picture of strong and vigorous treatment, side by side with this, relates to the question, "Has the national debt ever been paid—or is it only shifted?" Mr. Wiman makes clear that, if any one is bearing this weighty burden, it is the farmer on whose extrication all our hopes depend. The hope of the future is the revival of profit for the producer, and here again is another strong presentation in the treatment of the question of the "Future Food Supply," of the "Land's End," of "Fields a Thousand Miles Square," and literally a gallery of kindred subjects. Hung in with these vigorous touches there is a variety of episodes in legislatures, adventures in hunting excursions, and an infinite assortment of interesting and amusing matter. There are over 200 distinctive subjects treated, and the index shows over a thousand topics touched. As an economic treatise it is unique in its interest; as a book of stories it is unique in its strong and crude treatment of economic topics now in every man's thoughts, and universally discussed by high and low, rich and poor.

THE RELATION OF ECONOMIC CONDITIONS TO THE Causes of Crime. By Carroll D. Wright. Philadelphia: American Academy of Political and Social Science. [Paper. 8vo. 116 p.]

COLONEL WRIGHT starts out with the proposition that the causes of crime, in a sociological sense, cannot be studied without considering the statuts of man in the prevailing industrial order, for economic conditions contribute to the existence of crime. Crime was not so fully recognized under the slave and feudal systems as under the modern free-labor system. While the modern system is far superior to those that preceded it, it must be considered as having a direct relation to the causes of crime in so far as it superinduces idleness or unemployment. The lines of

crime rise and fall as the prosperity of the country falls and rises. The intelligent and skilled laborer is rarely found either in a penal or a charitable institution; and statistics show that no desirable working material can be found among convicts. Industrial depression makes tramps and criminals, while ignorance and the lack of technical training force men into the ranks of criminals. Too much cannot be done to avoid the misery of trade stoppages. Again, sanitary conditions are necessary to material prosperity; the health of the workers depends directly on the conditions of sewerage, light, ventilation, and housing. Ignorant labor implies ignorant employers. Undue subjection of labor is undesirable from the employer's own standpoint. The efficiency of labor depends on the standard of living to a great extent. Trade instruction, technical education, manual training, justice to labor, and equitable distribution of profits are efficient elements in the reduction of crime and pauperism.

SECOND REPORT OF THE BUREAU OF MINES OF ONTARIO. For the year 1892. Archibald Blue, Director. Toronto: 1893. [Paper. 8vo. 264 p.]

THIS report is a marked improvement upon the former one. It is more complete in its statistics and more systematic in its arrangement. The principal topics treated are: Statistics, iron-ores, iron-mining and pig-iron making, nickel and cobalt ores and metallurgy, new sources of platinum, utilization of peat, the mining laws of Ontario, etc., to which is appended the report of the inspector of mines. The summary of the mineral production for 1892 shows a total spot value of $5,374,000, and that in making this output wages to the amount of $2,591,344 were paid. In reaching the totals, however, a number of items are included which should be rather classed as manufactures than as crude mineral products, as, for example, brick, tile, cement, illuminating oil, lubricating oil, paraffin wax, etc. Among the leading products are: Gypsum, 3270 tons; salt, 43,337 tons; nickel, 2082 tons; petroleum, 28,000,000 gallons, and natural gas to the value of $160,000. The total value exceeds the production of 1891 by $668,466.

MASSES AND CLASSES. A STUDY OF INDUSTRIAL CONDITIONS in England. By Henry Tuckley. Cincinnati: Cranston & Curts.

THE aim of the author is to sketch the industrial situation in England as it actually is, dwelling particularly upon wages and the relation of the wage scale to the cost of living. Representative classes of workmen are dealt with, such as the 'bus- and train-men, clerks, railway-men, working girls, school-teachers, agricultural laborers, mechanics, and post office employés. To avoid dryness, figures are illustrated by personal facts. The author finds that the facts preclude altogether any rational comparison of British with American workmen, either as regards their present condition or their prospects. According to English sociological investigators, at the present time, of the working classes, one in two, if he reaches the age of sixty, is almost certain to come upon the poor law for his subsistence. Under these circumstances it is not to be wondered at that the labor question is in the forefront of English politics, or that the workmen are better organized there than in America, where opportunities and rewards are so much superior. Mr. Tuckley tells a melancholy tale, but he adheres closely to the truth. His little book contains useful information on the subject of "how the other half lives."

HOME RULE FOR OUR AMERICAN CITIES. By ELLIS P. Oberholtzer. Philadelphia: American Academy of Political and Social Science. [Paper. 8vo. 95 p. 25 cents.]

REFERRING to the failure of municipal government in the United States, Mr. Oberholtzer, after pointing out that it does not add much to the discussion to aver that the electors themselves are alone to blame if they permit dishonest and inefficient men to administer their municipal affairs, expresses the opinion that one of the primal elements in the difficulty is found in the relation between the States and the city governments. Cities are, with few exceptions, the creations of the States. The charters are liable to change at the pleasure of the granting power, and the interferences are frequent and contrary to the needs of the city. Mr. Oberholtzer

notes with approval the tendency to place restrictions on the legislatures in the matter of granting and amending city charters, and advocates a complete divorce of State and city. He would have our large cities stand in the same relation to the national government that the States do; he would make them "free cities," independent of the State legislatures. "The interests of all our large cities," he says, "are totally diverse from the interests of the remaining sections of the States in which they are placed by our artificial arrangement of boundaries," and he would have them make their own charters and constitute self-controlling, self-reliant governments. The subject is important, and new ideas should be carefully entertained by all who realize the need of reform in this sphere.

NOTES ON THE TESTING AND USE OF HYDRAULIC CEMENT. By Fred P. Spalding, Assistant Professor of Civil Engineering, Cornell University. Ithaca, N. Y.: Andrus & Church.

THIS little book is designed for use as a text in a short course of instruction as well as to serve the purpose of a handbook in the laboratory. The author gives a brief statement of the general properties and characteristics of hydraulic cement and its behavior under the more common contingencies of use. The various tests which may be applied are also discussed, and the precautions necessary in making tests of quality are pointed out. A chapter is added comprising a select list of recent periodical literature relating to the subject.

NEW BOOKS OF THE MONTH.

Ball, Sir Robert Stowell.—In the High Heavens: A Series of Sketches of Certain Parts of Astronomy. Illustrated. Philadelphia: J. B. Lippincott Co. [Cloth. 12mo. $2.50.]

Benton, G. Willard.—A Laboratory Guide for a Twenty Weeks' Course in General Chemistry. Boston: D. C. Heath & Co. [Cloth. 12mo. 163 p. 40 cents.]

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COMMENT & CRITICISM

The Cost of Mining Schools.

THE position taken in the October number of THE ENGINEERING MAGAZINE (page 111) relative to the maintenance of small mining schools is one that meets my views in every way. We have too many schools that are maintained under the false impression that they are doing great good to the State that supports them. It is believed by the supporters that every year a certain number of thoroughly-educated engineers are given to the world, when, by rules of reason, it is hardly to be expected that the graduates will be any better than the instructors of the schools, if as good. But these cannot be other than pedagogues, as you so clearly show. Here are some instructive figures from the *School of Mines Quarterly*:

Running expenses Columbia School of Mines 5 years, 1887–1891	$547,877.42
One-third general expense account—Heating, lighting, janitor	266,472.63
Interest 5 years on $1,000,000 real estate	250,000.00
Total for 5 years	$1,064,350.05
Receipts from fees during same period	234,457.88
Deficit, including interest	$829,892.17
Average expense per year	$212,870.01
Average receipts per year	46,891.58
Average deficit per year	165,978.43
Number of students during this period	252
Average cost per student per year	$841.00
Average receipts from each student, 20 per cent. of whom receive free tuition	186.00
Average deficit per student per year	$655.00
Deficit per student for 4 years' course	2,620.00
The general outlay for a period of 30 years, excluding interest charges, has been	$3,561,850.77
Receipts during same period from fees	898,308.15
Deficit, not including interest	$2,663,542.62

These figures speak in such a loud voice, it seems to me, that they should forever silence the smaller schools.

Would not the money used to support the small mining schools be placed to better advantage, if each State were to use it in bestowing scholarships upon young men who have shown special aptitude for the profession and send successful candidates of competitive examinations to some school of national reputation? Let such scholarships carry with them a prestige that would be an incentive to the recipient to maintain a higher standing in his class than the average student; let the candidates be matured in mind and body (not under nineteen years of age). It seems to me that such a course would result in giving to the world a few men of exceptional merit, which is what is needed to-day. We can trust the schools to turn out enough of the medium grade to fill in the places for which their ability fits them, while the credit of having brought a brilliant man to the front rank of his chosen profession is a far greater jewel in the crown of a sovereign State or Territory than giving to the world a number of men of only average ability and attainment. "Specialist" is the word of the day in the professions, as "trusts" is in the commercial world; they are *both* to be welcomed, and not condemned, as can easily be demonstrated, were it necessary.

New Mexico is to have a mining school —Rapid City, South Dakota, has one— Golden, Colorado, is struggling to live. Houghton, Michigan, is beyond doubt, the best equipped and progressive school west of the Alleghanies. I know something of the faculty of the three latter schools, and they may be summed up by saying that

they have at one or at most two good men as professors or instructors, the rest being graduates of other colleges with exceedingly limited experience in the commercial world. And what is of *more* value to an instructor in a technical school, than an ability to convey the essence of business, through scientific training, to the students? Success is the aim of all. A well educated man, who has been successful in the world, is personification of an ideal instructor.

For professorships, successful engineers call for large salaries because they are worthy of them. How can small institutions hope to do practical good with limited means,—with a pay-roll for professors and tutors that would not more than meet the salary of *one* man employed in our best technical schools?

Weed out the small, inefficient schools, send worthy students where their abilities will be recognized and their bents fostered and specialized by competent instructors.

RICHARD A. PARKER, C. E.

Marquette, Mich., November 2, 1893.

Suggestions for Reforming the Patent Office.

THE ENGINEERING MAGAZINE has recognized one of the most serious questions in the industrial world in admitting Mr. Redfield's paper on the evils and shortcomings of the Patent Office. I have never found a well-informed man who would deny that the American patent system needs reformation, though there is wide disagreement as to methods of reform. I believe that my experience warrants me in presenting my views.

There are two classes of applicants for patents: (1) producers of new and useful inventions and (2) inventors of patents. The substantial value of the invention *should* determine the right to a patent. *In consideration* of the applicant having disclosed a new and useful invention which will contribute to the welfare and prosperity of the people, the government grants a limited monopoly, which is, *or should be*, a valuable grant. Therefore, if the applicant fails to disclose an actual, new, and useful invention of substantial value, the patent grant, as a contract, is void for want of any consideration. In like manner, if the applicant performs, and the government fails to protect the monopoly, then the government fails in duty and honesty.

A majority of patents are void for want of consideration, because a majority of patentees are mere inventors of patents,—that is, designers of trifles, mere improvers within the field of ordinary mechanical skill, who add no whit to the store of human knowledge.

Consequent upon this enormous practice of dishonesty, an inventor is regarded an adventurer until he proves himself otherwise before a competent tribunal. This distrust is evinced in the disposition of courts to refuse preliminary injunctions upon patents not established by prior adjudication, and in the common contempt for patents.

The remedy is simple: *grant patents only for new and useful inventions which make a substantial addition to the welfare and prosperity of the people and contribute directly to the fund of industrial knowledge.* But the attainment of such end is impossible. True, but it may be approximately attained. I shall now present some means to that end.

First, the commissioner of patents and his department must be elevated to their proper place. The Patent Office has had a haphazard growth to meet the demands of the times. The commissioner has risen from a mere clerk to a judicial-executive position,—a position demanding a combination of rare capabilities. His duty embraces both writing opinions and keeping books; his salary is nominal; his position is political; and too often the position is used as a stepping-stone to fortune upon his retirement in the form of "Late Commissioner of Patents." The remedy for this is to make the commissioner an executive pure and simple, relieve him of judicial functions, pay him well, and appoint him for a long term of years. The judicial functions should be assumed by a judicial officer, well paid and appointed for a long term. The office should be made independent of the Interior Department, with independent financial powers, and *exclusive possession of its building*.

Second, the civil service management must be extended. At present the applicant passes his examination and secures his place in the department. In a majority of cases he is ambitious to rise; but in far too many cases he settles down into a mere clerk, ceases to grow, performs his duties mechanically,—in some cases without intelligence and occasionally with positive ugliness. Sometimes he becomes merely a small being in polite society, holding down his place for the position it gives and the spending money it affords. The remedy is this: the man must progress. He must not only come in under examination, but he must demonstrate his ability to advance, under examination occurring after a stated period of service in a given position, in order to hold his place. Such a provision would soon remove both the drone and the butterfly.

Third, the evil of all evils, the patent bureau and the "no-patent-no-pay" solicitor, should be wiped out. True this pestiferous supply is in response to a demand for cheap labor; but that is no excuse for its existence. I agree with the able writer in the December number of this Magazine (Mr. Redfield) that every solicitor should be duly admitted upon examination; but I would extend the examination to cover a good schooling, a mechanical education, a legal education, and thorough knowledge of the patent laws and rules.

Fourth, the form of the oath should require the applicant to *fix the date when his invention was completed, and the life of the patent should begin to run from that date*. The manifold evils, such as the two-year delay before filing and the delays in action, which such a provision would reach are apparent.

Fifth, applications should be subjected to all the existing tests, and also to the ultimate test of *utility*. This rule has been so well established by the courts in determining novelty, from the telephone cases down to the present time, that the Patent Office must enforce it. Space does not permit explanation, but a broad judgment applying this test would exclude no end of bad applications.

In conclusion, every remedy suggested goes to prevent granting patents void for want of consideration. When the integrity of every patent is largely established at issue the tendency to regard all patents with suspicion will disappear. The courts will then respect a grant under seal of the Patent Office, the public will attach a market value to the grant, and the whole field of industry will be relieved of thousands of patented obstacles to the exercise of true inventive genius.

WILLIAM MACOMBER.

Buffalo, N. Y., January 5, 1894.

"Boom" Towns and the Prevailing Depression.

THE article entitled "Causes of Failure in 'Boom' Towns," in the December number of THE ENGINEERING MAGAZINE, was a notable contribution to the understanding of a phenomenon of the first importance, and from the point of view of the entrapped investor nothing could be more illuminative or chastening. It does not appear to the present writer that Mr. Fleming's words call for any adverse criticism; but if one may be permitted to "comment" upon them, it does seem a pity that with such a favorable opportunity Mr. Fleming did not pursue the argument somewhat farther and connect these shattered "booms" with the present industrial depression.

That there is a vital connection and correlation between the two is apparent upon a moment's consideration. Manufacturing industries are dependent upon what may be called the primal industries, or those which extract wealth direct from nature, such as farming and mining. If anything interferes with production in these great primal industries a lessened demand for articles of manufacture makes itself manifest at once. A very perfect illustration of this relationship took place three or four years ago in the Argentine republic, where speculation in farming lands was carried to such an extreme that production was almost absolutely brought to a standstill, with the result that manufacturers in Europe were unable to go on, but had to sustain frightful losses.

In the United States, where agriculture has been languishing for a succession of years, our great outburst of speculation vented itself upon decidedly "primal" town-lands, in the manner described by Mr. Fleming. Undoubtedly there was in many instances good and sufficient basis for higher land-values; and wherever actual improvements took place the demands upon our manufacturers were urgent and effective; the building trades were stimulated to great activity, clothing-manufacturers were busy, and the innumerable intricate wheels of production and distribution were at full speed.

What stopped them, and why are they now idle? If Mr. Fleming has shown the causes of failure in "boom" towns, manufacturers and merchants could tell us the rest,—the dismal story of bad accounts, uncollectable debts, cessation of demand, poor business, dismissal of employés, final closing-down. Now this has been very widespread, for seemingly our "boom" was omnipresent and affected every corner of the country. That the acute crisis came finally in the shape of a financial paroxysm that shattered banks and ruined merchants and traders, follows naturally enough. The extenders of credit could gather in no returns. Production had ceased and products were not forthcoming.

Mr. Fleming has this to say in conclusion: "The lesson of the 'boom' will never be lost to those who were engaged in it, but no amount of preaching will prevent the repetition elsewhere of this state of affairs." Perhaps Mr. Fleming is right so far as preaching is concerned. But the taking of land-values in taxation would, by imposing a check on land speculation, prove a sovereign preventive; and one must believe, from the tenor of his article, that Mr. Fleming is in no sympathy with these periodical debauches, which, followed as they invariably are by lingering depression and widespread distress, take upon themselves the nature of a great national calamity. E. YANCEY COHEN.

New York, December 27, 1893.